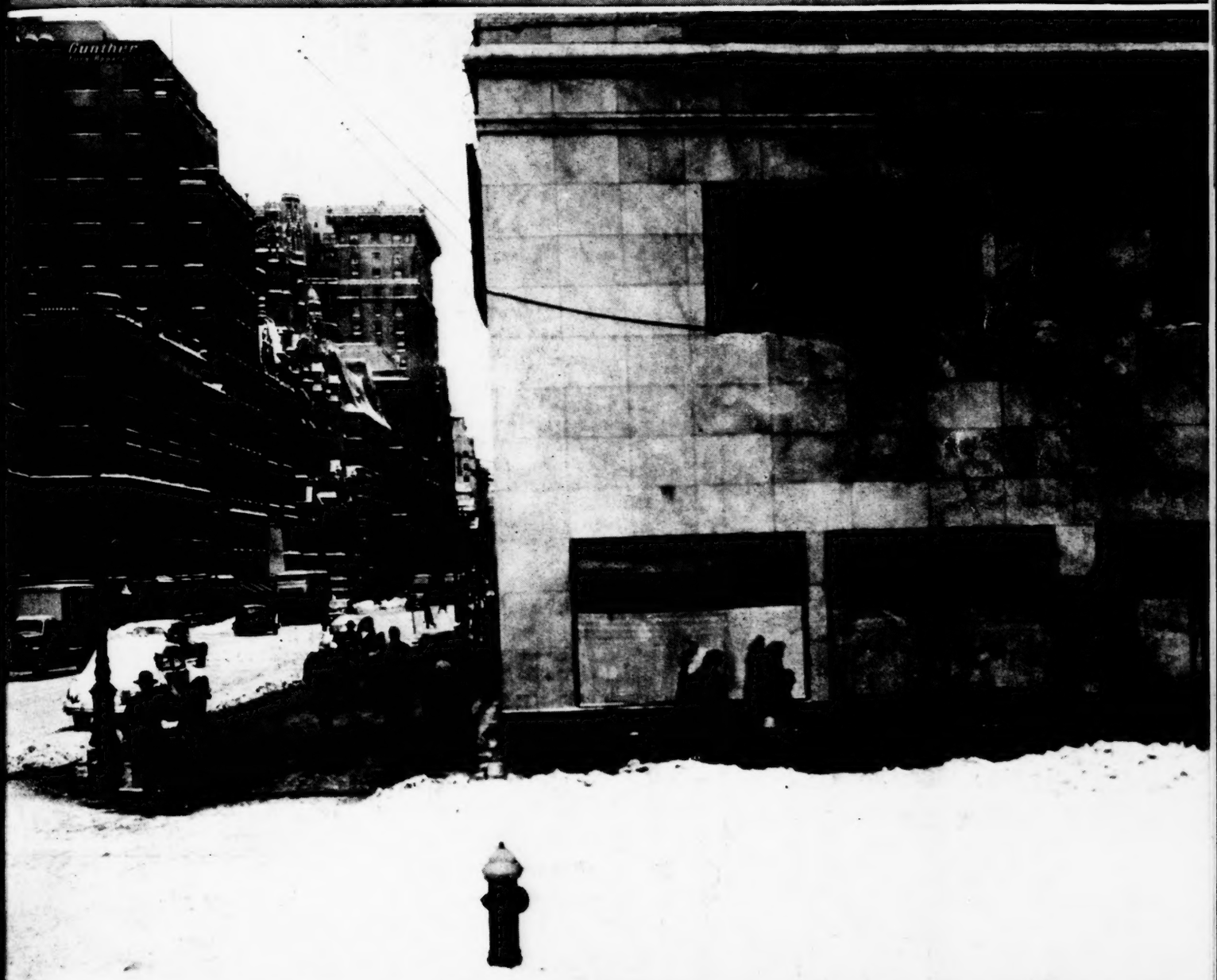
HEATING AND VENTILATING

AIR CONDITIONING, REFRIGERATION, PIPING, AIR SANITATION, HEATING AND VENTILATING



New York pedestrians appreciated Best & Co.'s snow-melting sidewalk while knee-deep drifts clogged other parts of the street. Iron pipe grids buried in sidewalk concrete carry hot water from the store's heating plant. Anti-freeze in water prevents freezing during off-periods. System was designed by Edward E. Ashley, consulting engineer of New York. Photo is by A. M. Byers Co. Snow-melting experience data gained by T. N. Adiam on various driveways is presented beginning page 61.

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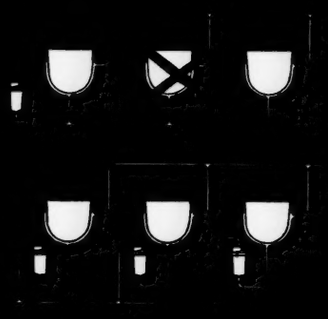

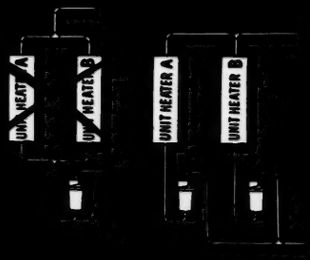

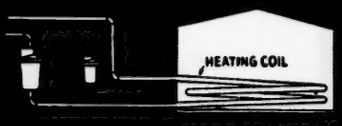

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VENTILATING

A MONTHLY MAGAZINE FOR ENGINEERS AND CONTRACTORS CONCERNED WITH THE DESIGN AND APPLICATION OF AIR CONDITIONING, REFRIGERATION, PIPING, AIR SANITATION, HEATING AND VENTILATION IN BUILDINGS

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THIS MONTH

The "Building Type Section," beginning page 65, inaugurates a new designation of articles which have to do with the special design problems of particular types of buildings. The subject this month is department stores. Others will follow from time to time.

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Washington News

LORING F. OVERMAN

IT will be months, perhaps years, before those in the heating, ventilating and air-conditioning industries will be able to judge the fruits of the first session of the Eightieth Congress. First impression will be that Senators and Congressmen, in their haste to adjourn on schedule, left more undone than done.

Perhaps this is all to the good, for there is a strong conviction that what this country needs is fewer and better laws; not more of them. Entering the Congressional halls in January under the "It's Time for a Change" banner, members of the Eightieth had their pockets laden with bills proposing quick about-facing. It soon became apparent, however, that re-tooling a political machine also takes time, and that while the process is under way, production stops.

Thus, of the tremendous grist of proposed legislation thrown into the hopper, relatively little of major importance actually emerged.

Among them was the labor law, passed over the President's veto. Already the efficiency of this measure has been clouded, to say the least, by the ease with which John L. Lewis avoided no-strike penalties and accomplished his objective—more money for his miners.

Then there was Rent Control law, which extended controls through February 29, 1948, but terminated all construction restrictions with the exception of those pertaining to amusement properties. Yet under this law, rents are zooming upward daily, while the expected flood of new construction appears dammed (or is it damned) by astronomical costs.

Congress must be credited with having tried hard to effect tax reduction, but the Presidential veto proved too stiff a hurdle.

Unable to provide a long-range housing program through the medium of its Taft-Wagner-Ellender housing bill, which died with adjournment, Congress did take some notice of the housing situation by sort of a default. The Senate, reversing the action of the House, accepted President Truman's Reorganization Plan No. 3, which creates a permanent unified housing agency. The new agency, to be known as HHFA—the Housing and Home Finance Agency—will continue the central housing agency plan authorized by wartime legislation. Had the plan been disapproved, housing activities would have reverted to 13 separate agencies in seven Government Departments.

Raymond M. Foley, administrator of the National Housing Agency, was expected to take over as head of the new HHFA. Under the reorganization plan, Mr. Foley would have under him the Federal Housing Agency (FHA), the Federal Public Housing Agency (FPHA), and the Federal Home Loan Bank Administration (FHLBA).

Best Forget Prewar

Although the President's economic report attributes current highs in production, demand, prices, and wages to the needs of devastated countries overseas—a condition which he says should be considered only as props to our present economy—his economic advisers contend that we may as well stop looking back wistfully at prewar costs.

"A large part of the increase in prices since 1940 has become imbedded in the cost and income structure of the economy," the report observes. "Hence, a decline to the pre-war level could be expected only as an accompaniment of a depression. That we are all determined to prevent. Nonetheless, prices should be revised downward where profits are excessive, or where reductions are needed to forestall a collapse of markets."

In this connection, the President urged that fundamental adjustments be made in housing costs. "Housing remains, in some respects, our domestic problem number one," the President commented. "Nowhere are cost reductions more important to the whole economy than in the field of construction."

Just how cost reductions are to be accomplished in any industry in the face of current upward pressure, the President failed to explain in his economic report. He merely classified as "wholly unjustified" any spiral of prices, particularly in steel, which might be expected to result from recent increases in the price of mining coal. In this conclusion he appears virtually alone, for Washington observers are unanimous in forecasting otherwise.

They regard an increase in the price of steel as an inevitable result of any advance in the price of coal. Guess is $2 per ton average for steel products, with specialty items much higher. Next guess is that things made of steel will reflect the increase, and so on. Seems logical.

Steel Shortage

Meanwhile, regardless of price, Washington is taking an increasing interest in the steel shortage. It is concerned with two angles—distribution of present supplies and the possibility that capacity is insufficient to meet the new postwar needs. Scheduled for mid-August is a Senate sub-committee hearing to explore the possibility of a voluntary inter-industry solution of the distribution problem. And ready for consideration by Congress at the next session is a bill to loosen up Government funds to provide additional capacity.

Suggested as a solution to the distribution problem is a five-point code of ethics.

1. Agree to stop making tie-in sales, requiring a turn-in of scrap in deals for finished or semi-finished steel.

2. Determine needs for steel and agree to manufacture in sizes and types needed.

3. Ship steel where it is needed, and not just to territories where there are no extra freight charges.

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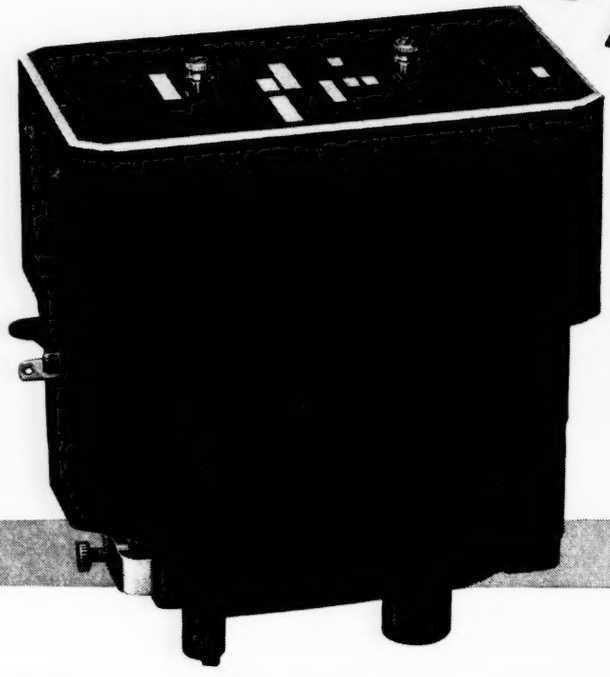

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CRC-239 FH operates in the same way, except that the induced draft fan is cut off at low fire, for which natural draft is used.

CRC-239 FN is for use with burners not having induced draft, or for those burners having continuous forced draft at both high and low fire.

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4. Agree not to accept premium prices for steel to be exported.

5. Utilize any existing surplus steel-making capacities to the fullest to produce for legitimate customers at legitimate prices.

Sponsors of the code of ethics comment that some scrap dealers have taken advantage of the situation by selling their scrap to mills which will in turn furnish them with semi-finished or finished steel. Almost invariably, observers comment, steel so obtained is placed on the black market.

Particularly criticized was the practice of accepting premium prices for steel to be exported. Such prices, it was claimed, are paid by foreign buyers who have borrowed taxpayers' dollars from this country.

Under the Congressional proposal that capacity be expanded, the Government would make long-term loans to private industrialists. Alternatively, the Government could build additional plants with its own funds.

Industry's view is that the steel pinch will soon ease, and that there is no need for plant expansion. Supporters of the expansion plan contend that the Marshall plan for the rehabilitation of Europe justifies a broader view. They contend that unless German steel production resumes at a higher rate, increasing foreign demand will continue to compete with our own expanding industry, which has estimated it will require 100 million tons annually by 1950.

Industry contends that the current shortage is the result of past conditions which are not clearing up. It points out that during most of this year, operation has been limited to 85% of capacity due to shortage of scrap; that three serious strikes slashed output during six of the 12 months of 1946, and that new rolling mill capacity of 2½ million tons is new under way—its completion delayed only by strikes in electrical equipment and machinery industries. This new capacity, the steel industry points out, will bring relief where the squeeze has been tightest, in sheet steel and strip.

Fuel Sources

Of direct interest to H & V readers—for both immediate and future consideration—is the current controversy concerning the availability of fuels. In each classification—coal, gas, oil and electricity—there have been rumors of possible shortages. Conclusion appears to be that shortages, if they develop, will be largely local.

In *coal*, barring an unexpected strike or shipping tie-up, the outlook is favorable. Yet a number of important factors are involved. Estimates are that coal has lost 40% of the total fuel market since 1900. Even since 1945, railroads have reduced coal use 15% by operating Diesel locomotives, and are currently ordering 8 Diesels to one steam locomotive.

In home use, a National Housing Administration survey indicates a further drop, only 27% of 1,000,000 veteran homes planning coal heat. In industry, coal tonnage per unit of electric energy has been reduced 60%.

Those in the H & V industry whose futures are linked with coal may wish to keep in close touch with research projects being undertaken by the coal industry, and by the Bureau of Mines. Contending that domestic reverses of coal are much greater than those of oil, research seeks to recapture lost markets. Further development of the productivity of mines has been suggested as one means of reducing per ton prices, while projects in the marketing field involve liquid coal (a mixture of oil and coal) generation of gas directly from the mine, and coal-burning gas turbines. Also suggested, in view of probable increases in freight rates, is a check of the comparative cost of high-grade versus low-grade coal.

The *oil* situation finds demand approximating supply; the former at 5,733,000 barrels per day, production at 5,764,000. Little lack of crude oils is reported, but shortage of materials has hampered refinery construction; lack of transportation facilities involves crude and refined products; labor troubles continue, and storage facilities in some areas are short.

The oil industry appears to have spotted probable shortage areas and is generally taking extraordinary precautions. It is considered likely, however, that prices will rise to cover these extra services in transportation in storage; that supplies of crude and refined will be tight for a year or more (or until) the steel shortage eases), and that the heating outlook is not good for either the Midwest or the East Coast. Longest pinch will be in the Midwest, where additional pipeline facilities will not be completed until early in 1948.

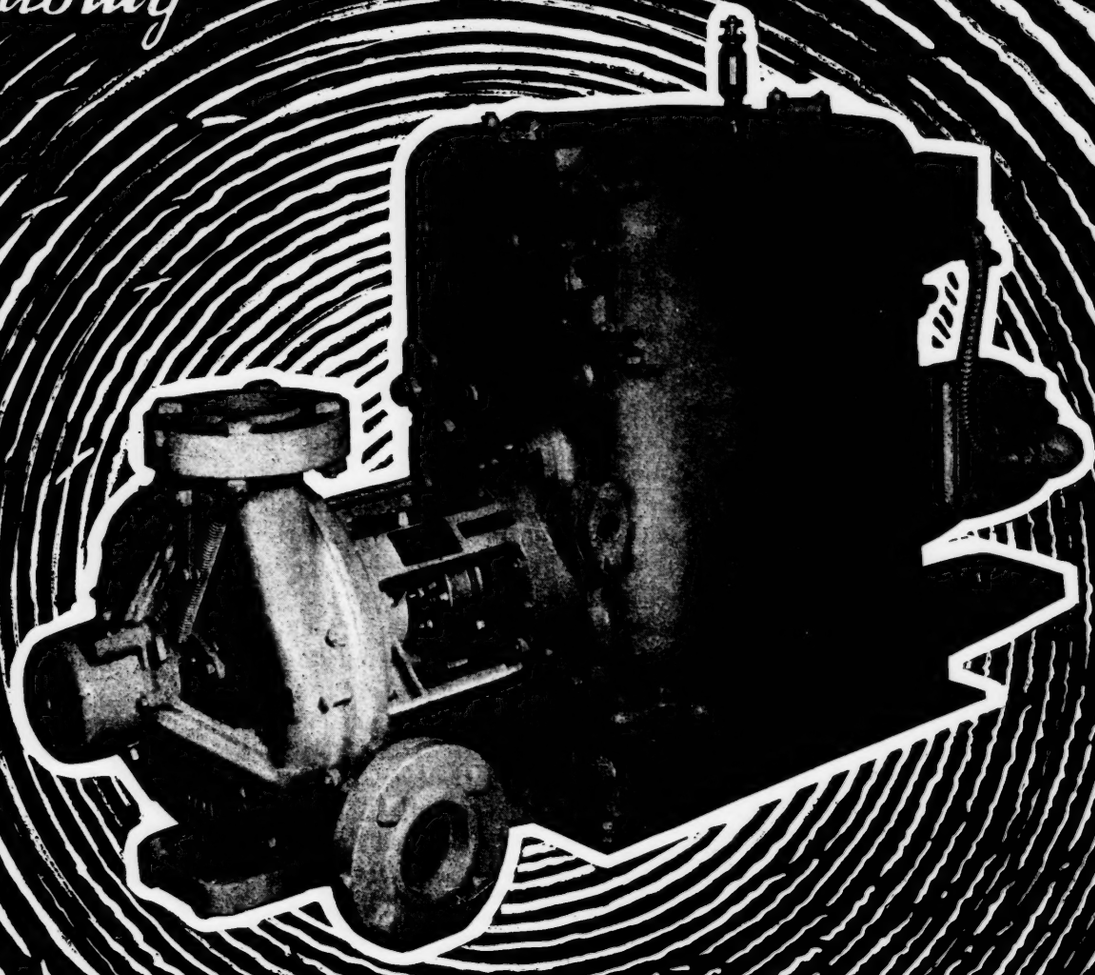
The *gas* outlook—natural, manufactured, and mixed—faces two difficulties. Demand is increasing at the rate of 10% per year, but a billion dollar expansion of distribution facilities, planned for 1947, is being delayed by steel shortages. Most likely to experience restrictions will be areas using manufactured gas, although new methods of producing higher BTU gas will assist. Expected increase in deliveries to the East via the Big and Little Inch pipelines is regarded as the best hope of steady supply for Atlantic Seaboard states. The converted lines, during the winter of 1947, are expected to double their output of last winter.

Power

Electric power shortage predictions may be discounted considerably, observers anticipate. Surprisingly, however, electric power needs today are above the prewar peak—with a 15% increase expected this year over 1944. Industrial use of electricity is up 93% over 1939; commercial use up 59%, and domestic consumption up proportionately through new users and increases in per capita use. Since 1939, new non-farm users increased by 5,463,285, and 1,571,700 farm users were added to the lines.

As in the case of other industries, the power group's plans to expand capacity by 20% during the next three years will depend upon supplies of copper and steel. In addition to distribution problems, two thirds of the plants comprising the industry are subject to possible shortage of coal or oil. Only one-third of the nation's plants are hydro-electric.

Centralized Heating Economy



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HEATING AND VENTILATING

Snow Melting by Embedded Pipe

T. NAPIER ADLAM

Vice-President, Sarco Manufacturing Co., New York, N. Y.

Results of snow melting studies conducted during the past winter. Photo-electric control for automatic delivery of hot water to buried pipes is described.

DURING the past winter much headway has been made in various parts of the country with snow melting systems. Roadways up to 600 ft have been successfully cleared by snow melting systems. The writer has dealt with some fairly large systems for parking areas and industrial driveways, and has also been able to carry out some further tests on different snow melting systems. Since we had some very heavy snowfalls, the results in relation to outside temperatures were, in several instances, very interesting and helpful.

On one or two occasions the tests were made when the snow storms were preceded by a spell of very cold and dry weather, with outside temperatures remaining close to zero, followed by a fairly rapid rise in temperature and a heavy fall of snow.

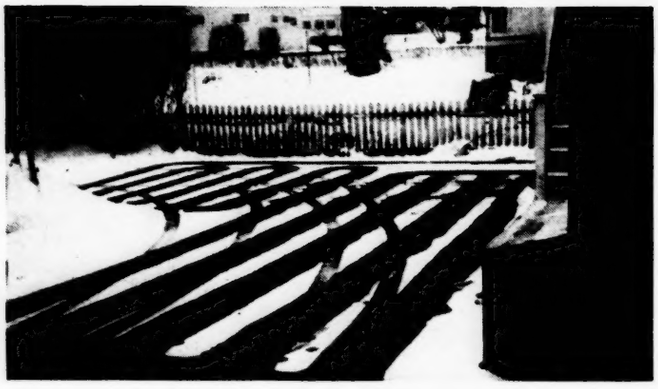
At other times when I made tests, heavy snowfalls were accompanied by very strong winds, almost of blizzard proportion, which caused the snow to drift to several feet in places.

Generally speaking, it was found that where the systems were in operation before precipitation started, there appeared to be no difficulty in keeping the surface above the pipes free of snow, but where heat was turned on after precipitation started, the results differed widely, depending on several factors. It depended not only on the amount of snow already accumulated on the driveway, but also on the air temperature and wind velocity at the time of melting, the temperature of the ground prior to the snowfall, the depth of the pipe coils below the surface and, of course, on the temperature of the circulating medium.

Actual observations made on heat emission from the embedded pipes confirmed in a remarkable way the earlier data of the author.* It must be remembered, however, that if a system is designed for melting 1 in. of snowfall per hour, and there is already 4 to 6 in. of snow on the driveway before the heat is turned on, a few hours will be required to melt this snow, in addition to the time which will elapse in warming the soil and surface of the driveway. If the snow continues to fall under such conditions, then it is probable that the surface of the driveway will not be cleared of snow entirely until several hours after the snow ceases, unless there is a large margin on the heating system. This result does not in any way condemn the principle of the system; it merely demonstrates one or two weaknesses in the particular installation, or in the method of starting.

While the heat emission from embedded pipes can be correctly computed*, and the amount of pipe cal-

*See "Radiant Heating" by T. Napier Adlam, Chapter 15, pages 321-347. Published by THE INDUSTRIAL PRESS.



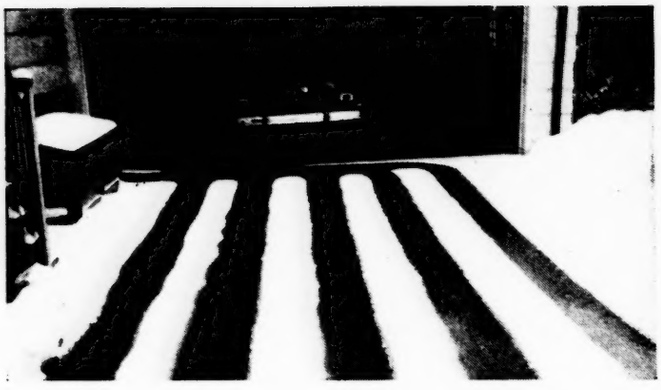


Fig. 1 (upper). Driveway 30 minutes after a 3 to 4 in. snowfall with heat turned on shortly after snow started to fall. Fig. 2 (lower). Another view of same driveway but photographed 15 minutes prior to Fig. 1.

culated according to the depth of snowfall per hour to be melted, the results of the author's recent tests seem to prove that if it is desirable to keep the whole surface absolutely free of snow, the pipes should be no more than 10 to 12 in. apart for asphalt driveways, and no more than 15 in. apart for concrete roadways or heavy sidewalks.

With heavy concrete construction the heat is rapidly conducted through the concrete and can spread more evenly over the surface between the pipes, whereas with the thinner layer of asphalt the heat travels quickly to the surface of the driveway where it quickly melts the snow and then gives off part of the heat from the bare asphalt surface to the atmosphere. Sometimes quite a cloud of vapor can be seen rising from the bare surface. Of course, it is not absolutely essential to melt the snow from the whole area of a driveway, and in most cases it is quite sufficient to melt enough of the snow to allow for a narrow footpath, or to permit vehicular traffic.

To show the effect of this on an asphalt driveway, a series of photographs were taken under different conditions. Fig. 1 is a photograph of this driveway taken about half an hour after a 3- to 4-in. snowfall. In this case the snow melting system had been started a short time after snow had started to fall, and it will be noted how much of the snow had melted; marks of car wheels over the unmelted portion of the snow can also be seen. The amount of unmelted snow in this case does not present any serious objections, even though the pipes are 24 in. apart.

Fig. 2 is a similar portion of the same driveway but taken in the opposite direction about a quarter of an hour prior to Fig. 1. Thus it may be seen how gradually the snow melts and how the melted portion spreads out sideways and the strips of bare surface become wider as the heat is conducted along the asphalt.

Fig. 3 is of interest as it shows the effect of melting tracks for vehicular traffic on a fairly long driveway.

When the snow is allowed to accumulate before the system is started, the results are similar but, naturally, it takes time to warm the ground first and then melt through several inches of snow. Under these conditions one first notices a depression on the surface of the snow as it sinks when melting takes place below. Gradually, the depression gets deeper until the surface of the driveway directly above the embedded pipes is discernible.

Fig. 4 was taken about three hours after the system was started and 6 to 8 in. of snow had already accumulated before the heat was turned on. Fig. 5 was taken later and shows how the melting extends, a process which continues until the surface is free of snow.

It will be noted in Fig. 4 that since snow had drifted near the fence to a depth of about 12 in., the melting had not taken place over the whole area of the coils.

One other point clearly demonstrated in these tests was that the heat emission from the pipes became greater as the snow started to melt and the water percolated through the asphalt.

Although the Btu emission from embedded pipe coils depends on the temperature difference between the pipes and the surroundings, it was found that as melting takes place and the soil and asphalt surrounding the pipes becomes moist, the heat from the pipes

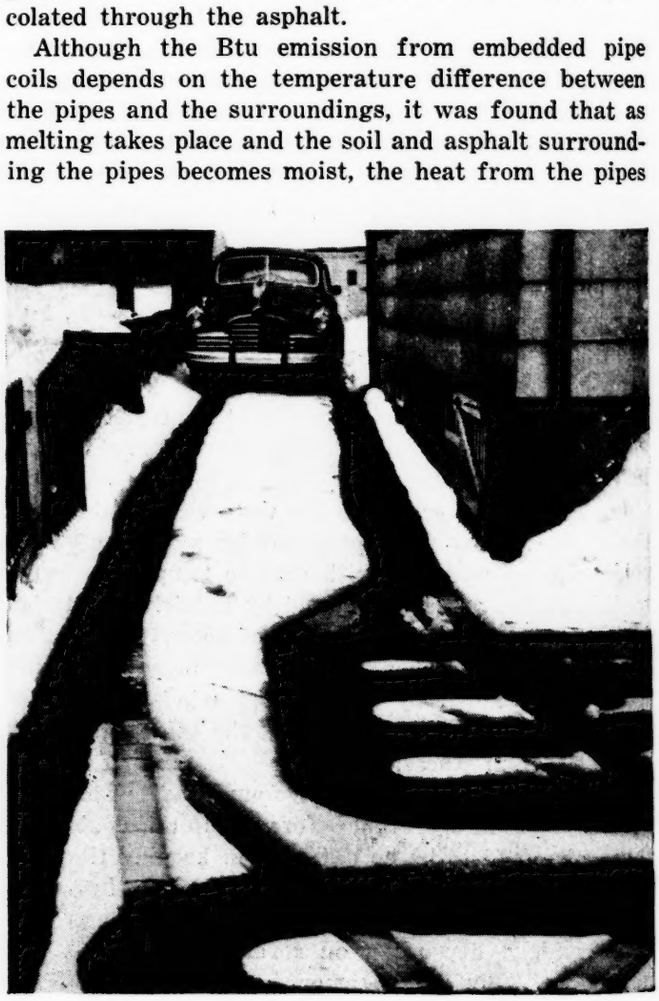


Fig. 3. Effect of melting tracks for vehicular traffic on a long driveway.

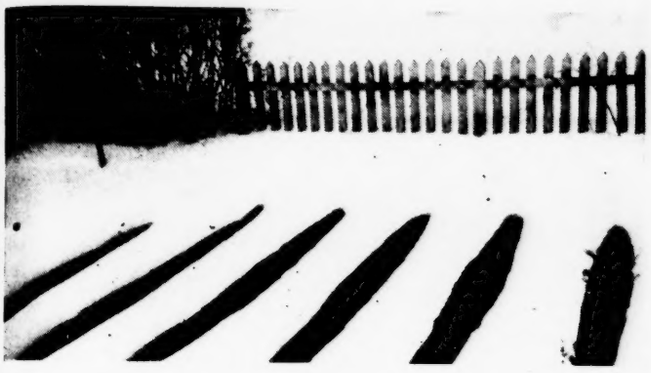


Fig. 4 (upper). Heat turned on after 6- to 8-in. snow had fallen. Photograph taken 3 hours after heat was turned on. Fig. 5 (lower). Twenty minutes later, showing how the melted strips had widened.

and the conductivity downwards through the soil increases considerably. Therefore, to obtain the full advantage of a snow melting system, it is imperative to provide a good margin to the boiler power. It appears well established that a 50% margin above the heat calculated for melting the maximum snowfall, plus the heat loss downwards, will give excellent results.

While it is an advantage to maintain a relatively low water temperature in the coils at all times when snow is predicted, and to turn on the full heat directly a snow storm commences, there are cases where it is considered undesirable to maintain the heat continuously because of running costs. It is then that an automatic starter will be found very useful.

Several types of starters for this were tried and two which were found to be very satisfactory are worthy of more detailed consideration.

One is the suspended plate type, Fig. 6; the other is a control using the photo-electric cell, first designed for snow melting systems by Clement H. Wells, President, Sarco Co., Inc.

Fig. 7 shows this unit supported on columns with the reflecting plate cemented to the sidewalk above the embedded pipes, exactly as used on test. Fig. 8 illustrates the principle of this unit with the rays travelling in the direction *X*, *Y*, *Z*. The polished surface *Y* reflects the rays impinging from *X*, while the electric switch in the controlling unit at *Z* is open and no current passes. However, as soon as snow falls on the polished surface at *Y*, the rays are interrupted and diffused instead of being reflected. This allows the switch to close and automatically turns on the heat for the snow melting system. This is the system actually used at the Sarco factory. When the current is switched on it opens a motorized steam valve and simultaneously starts the pump. Similar arrangements can be made to operate any kind of system, including an oil burner and pump, or a gas burner and pump.

Fig. 6. Suspended plate type of heat control. Fallen snow depresses plate and activates snow melting system.

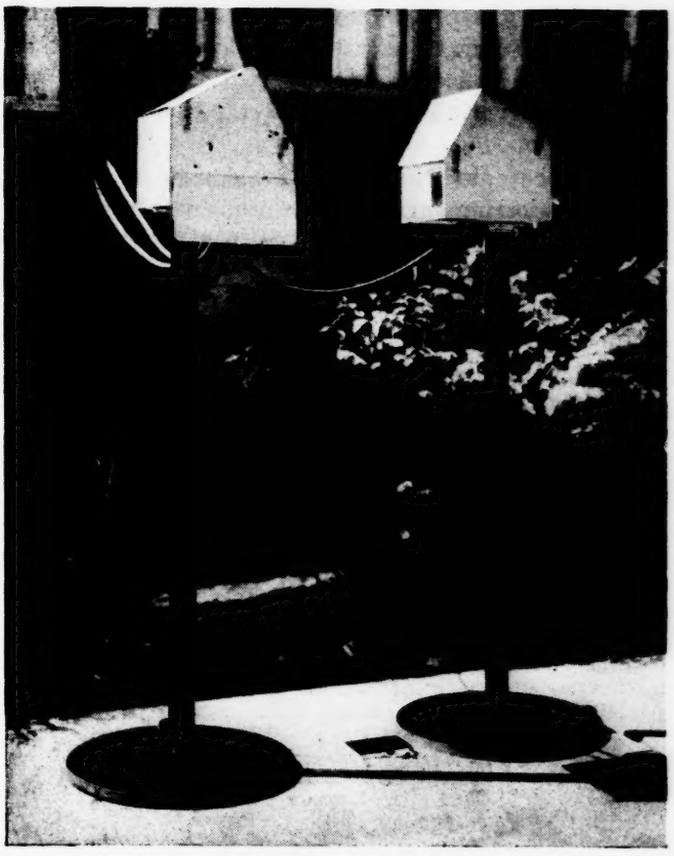


Fig. 7. Control employing photo-electric cell. Reflecting plate is on the ground between the two stands.

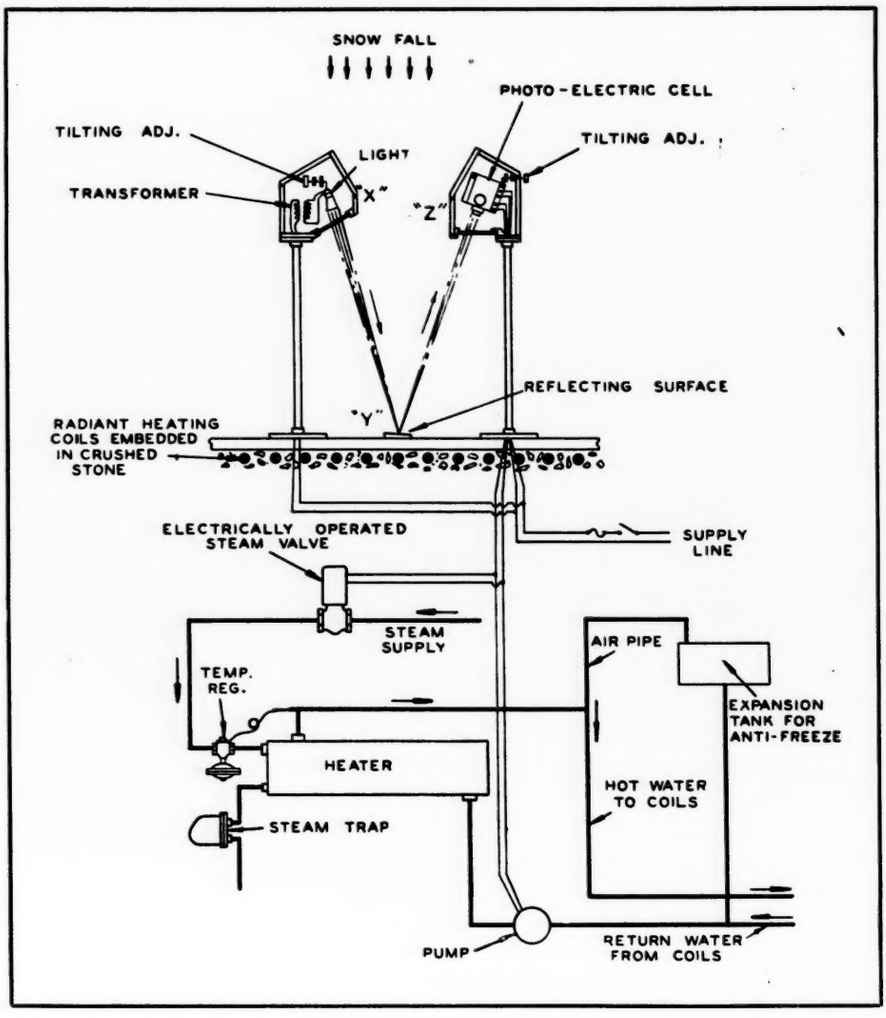


Fig. 8. Schematic diagram of system using photo-electric control with reflector plate.

This particular design was introduced so that immediately the heat from the embedded pipe melts the snow on the reflecting surface *Y*, the light rays will again be reflected into *Z* and the heating system closed down.

It will be noted that the polished plate is cemented to the supporting surface at a slight angle, so that any water from the melted snow will run off the surface freely, as will any rain which might otherwise remain on the surface and interrupt the light rays.

In the event of an ice storm, ice will collect on the plate *Y* and diffuse the rays, thereby turning on the heat and keeping the driveway free of ice as well as snow.

This same type of instrument can be placed in any other position away from the actual surface to be heated, and the reflecting plate, when covered with snow, will turn on the heat. However, when the plate *Y* is not supported on the surface heated by the coils, the system will continue to operate until closed down manually, or until the snow has been removed from the plate manually, or by introducing an electric heating element under the plate. However, it does appear to be very advisable to have some means of starting the system automatically, unless it is decided to operate the system continuously.

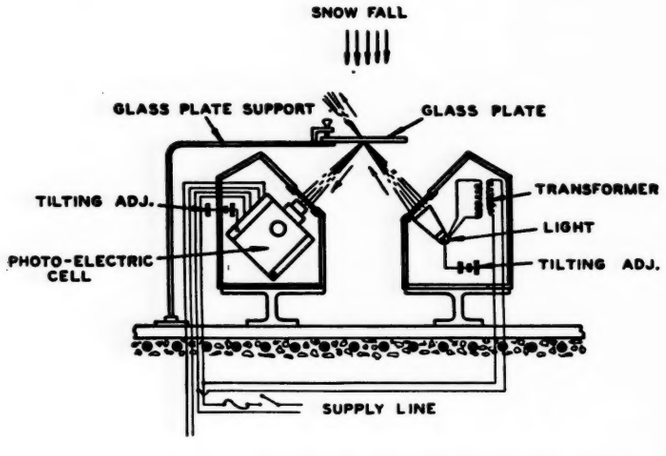
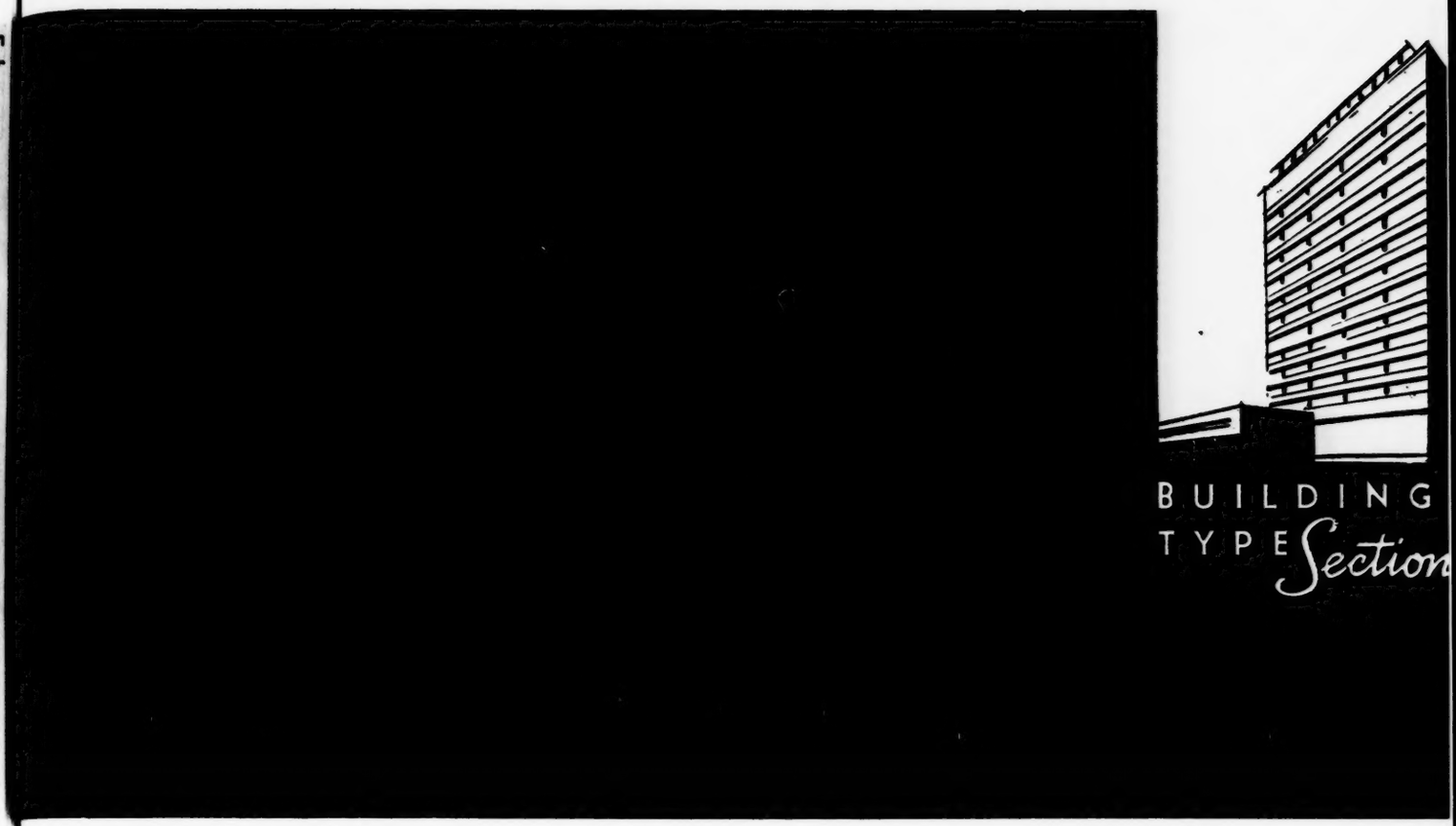


Fig. 9. Use of photo-electric cell with transparent glass plate as part of the control.

The writer has experimented with this photo-electric cell control in several other ways. One experiment involved the use of a plain glass reflecting plate as shown in Fig. 9. In this case the rays were allowed to pass through the glass plate *Y* until snow collected on the top of the glass—when the rays would be reflected into the receiver and start the system. However, this method was not entirely reliable and was rejected.

The original intention was to use the black rough surface of the driveway as an absorbing surface for the rays emitted from the light at *X*, Fig. 8, and to rely on the white snow to reflect the rays into the receiver *Z*. However, due to the crystalline structure of snow, the rays are not truly directional and the light rays are scattered instead of being reflected. Consequently, this also was found unreliable and the polished surface shown in Fig. 8 was adopted and proved to be the most effective.



Certain types of buildings pose engineering problems peculiar to their class. Special problems in the design of air conditioning systems for department stores are discussed in this initial "Building Type Section." Other such sections will be published from time to time.

AIR conditioning of large department stores with their vast floor areas, variable ceiling heights, lighting loads and density of shifting population, with accompanying differences in internal heat load, present some very interesting problems that only experience and ingenuity of the trained engineer can solve. No other class of building presents within a single structure so many different and fluctuating requirements, changes in departmental location, arrangement and space allotment, and so many extensive alterations and additions to the structure itself.

The problem does not terminate with completion of the first approved design, but continues with the shift in merchandising ideas and the treatment of interior decoration throughout the entire construction stage. For that matter, no air conditioning system in a large department store is ever complete, but must forever follow the kind and volume of things sold, the changing ideas of a live store management, and the versatility of a creative store architect.

Existing kitchens, dining rooms, beauty parlors, and even a series of toilets one above the other, may be ruthlessly relocated, together with all their ramifications of plumbing risers. Such space may then be surrendered to elevators, escalators or much needed sales area, but whether the changes are many or the physical conditions ever so tight, there still is a reasonable chance that a good air conditioning system can be installed and maintained as long as partitions and decorative treatment are not arbitrarily fixed.

Partition Changes

The partition of this week may disappear next week, or be relocated, or be turned at some angle no one could foresee. It may go to the ceiling or it may not, but wherever it goes the designer must constantly keep in mind such possibilities, if not probabilities, so that the supply and return air will still circulate and be diffused throughout the conditioned space, and do so without an objectionable draft at any point.

A partition location should have possible alternatives. It should be capable of a shift from the "must" position and yet satisfy the needs of the store, or be near enough to be consistent with the expenditure and damaging effect otherwise entailed to the operation of the various mechanical utilities. If the decorator had to operate the air conditioning system, he would soon find some compromise. Suitable space, arrangement and eye appeal, of primary importance to the sale of goods, fall short of their objective where the customer is made uncomfortable by drafty conditions.

Changes are often made without fully weighing all the indirect costs against the results obtained, or without considering the cumulative effect of constant change upon air conditioning results. Partition changes, of course, vitally affect the flow of air from outlets, more particularly those of the forward blow side wall type. Such changes also affect sprinkler head locations and arrangement of lighting fixtures. A change in any one of these usually ends up with the

Fig. 1. Utilizing the center cone of an air outlet for direct lighting

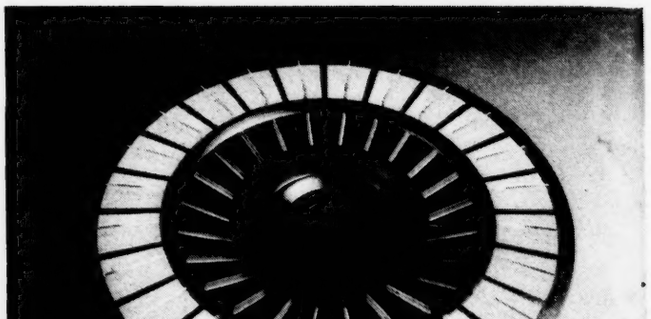


Fig. 2. Utilizing the center cone of an air outlet for fluorescent lighting

necessity for relocating all the others. Ceiling outlets, one central in each bay, as a rule are least affected but those near the outdoor perimeter of the space must be carefully located to avoid interference with their air delivery when subsequent changes are made in outside rooms.

The Ceiling Problem

In new construction, all mechanical services at the ceiling should be carefully studied and coordinated on a ceiling plan. Which should have the priority—the sprinkler heads, the lights or the air outlets? The sprinkler head spacing is fixed by certain rules, the air outlets have the job of making a space comfortable, and the lighting arrangement must be both artistic and useful. Lights are strategetically used to get the customers in, keep them in as long as possible, and enable them to get out, but it is not always possible to design a lighting arrangement which considers the ceiling as its own, yet allows the proper location for all other services.

The ceiling problem is greatly simplified, however, where the lights in certain areas can be combined with the air outlets. Such outlets deliver air through the outer cones and normally take return air back through the center cone. In Fig. 1 this center cone has been utilized for the insertion of a light reflector of any design. In Fig. 2 a design employing fluorescent lights is shown.

The center cone may be further used for a flush type loud speaker, though the loud speaker is sometimes concealed within the duct at the outlet; or the center cone may be utilized as a hanger to support some ceiling display. Sometimes it is desirable that the light be suspended well down from an outlet, or that the center cone be used to take a sprinkler head and so be rid of that particular problem.

Finding a Way Out

Above the first floor there usually are a number of specialty shops or departmentalized sales zones partitioned off into square, oval, round or irregular shaped areas. Such departments are subject to change or to creation over night. Partitions may or may not go to the ceiling. In any event, the departments are confined and the space is usually hot.

Fig. 3 suggests one way of meeting the situation, using one inverted central outlet supplied from the floor below. Other applications of this idea are shown in Fig. 4 and 5. One such outlet could well be used on the top of an information booth.

One will have to look hard to observe that the apparent circular ceiling outlet with concentric cove lighting in Fig. 6 is in reality but a half circle cleverly bisected by a mirrored wall. It shows what can be done to create an illusion of a larger area.

The Side Wall or Half Moon Outlet

The side wall or half moon outlet also has its possibilities, Fig. 7, where it has been combined with a fire exit sign over a doorway. Two of these half outlets may be combined to form a circle, Fig. 8, so that the upper one serves as the supply outlet and the lower one as a return inlet. They may also be mounted on interior columns, Fig. 9, but the mounting of four such outlets per column, as was done in one installation, will lead to difficulties. Air from outlets will oppose one another or discharge against the surrounding low partition. Only the outlets designated as *A*, *B*, *C* and *D* should be used.

It is customary with air conditioning units to terminate the vertical discharge outlets with one of these half moon outlets as shown in Fig. 10. A duct system may be connected to the same type of outlet where there are windows above the shelves on the exterior walls and no hung ceiling overhead. See Fig. 11. The only space that could be utilized for ducts in the actual installation as sketched was up through the shelving.

Electronic Filtration

Store owners and managers are primarily merchants. They buy and sell. Gadgets help to sell, so they frequently look for them and sometimes the utilities are not given sufficient consideration. In one case an expert's report cost $7500, but it was filed for it con-

tained nothing unusual. In another case, someone thoughtfully checked the survey of the expert against the employees' suggestion box of ten years' standing, and the accumulated suggestions were found to be in agreement with nearly all of the report. So this report was likewise filed away.

Filters, other than the electronic or electrostatic type, remove much of the larger dust particles, but the dust that makes the smudge on merchandise is still left. The electrostatic precipitator is therefore the nearest approach to an air conditioning gadget that can be offered store management. This type filter, because of its unusual features, immediately created an interest which has been stimulated by the possibilities for eliminating much of the store dry cleaning, time spent in covering merchandise, dusting, reduction in soiled merchandise and redecoration. Air conditioning coils are also maintained in a cleaner condition. There is the further advantage that bacteria are caught by the filter.

Bacteria ride the returning dust particles, but they would otherwise settle to the floor since most bacteria are heavier than air. Sterilamps are space takers and are expensive, but no doubt will ultimately be commonly included in the store air conditioning system.

The first cost of an electrostatic filter is high, but not too high for the results obtained, even when it is combined into one unit with the mechanical or fully automatic self cleansing type which eliminates the need for a shutdown period for maintenance purposes. As the size of these filters is increased, their cost becomes proportionately less for the volume of air handled.

Zones of industrial smoke should not be the sole criterion when evaluating the need for an electrostatic filter. Whether or not a particular city has a fairly clean atmosphere, the fact remains that any atmosphere seems to contain enough dirt to soil merchandise to the extent that it depreciates in value. It is not fully appreciated that only a small quantity of dirt will produce spoilage. Some managements remove goods most susceptible to damage by dirt to another store area which shows less dust content by instrument, and where this is done, it is still found that there is enough spoilage to produce a substantial loss.

There Will Always Be Some Dirt

There will always be some dust in any store, but it can be reduced to a harmless degree by good maintenance, proper filtration, sufficient cooling to stop spoilage from perspiring hands, and by filtering all areas from which air may enter, such as open stairways or other passages.

The amount of outdoor air to fans should be sufficient to offset the flue action or stack effect within the building and exfiltrate the air or pressurize the space, thus preventing the infiltration of dusty untreated air. Incidental advantages of a good amount of outdoor air are odor reduction and the elimination of drafts from cold outdoor air. Windowless construction also helps to keep down the amount of dust and drafts and reduces the quantity of outdoor air otherwise required. With such type of construction the quantity of outdoor air must be reduced unless positive exhaust fans for the relief of pressure are provided.

Covering cloths on sales counters protect merchandise from dust during the quiet hours that the store is closed, particularly where dusting and floor cleaning are done in a manner to raise dust. Cloths become dust-loaded unless frequently laundered, and when loaded continue to stir up dust as they are folded and put away in the morning.

Some store areas may have more dust due to an insufficient air supply or movement to return the dust to the filters. A considerable traffic and handling of goods requires enough air to prevent the dust particles from settling out. Once on the floor, these particles are kicked up repeatedly by the traffic which incidentally adds its own dirt from shoes and clothing.

Sheet metal between filters and fan outlet should have all seams soldered airtight and doors made airtight with gaskets to prevent any air from by-passing the filters. Screens at return air inlets prolong the life of the ordinary type of filter, reduce the amount of filter maintenance, and stop their plugging from lint. Merchandise displayed under glass has some pro-

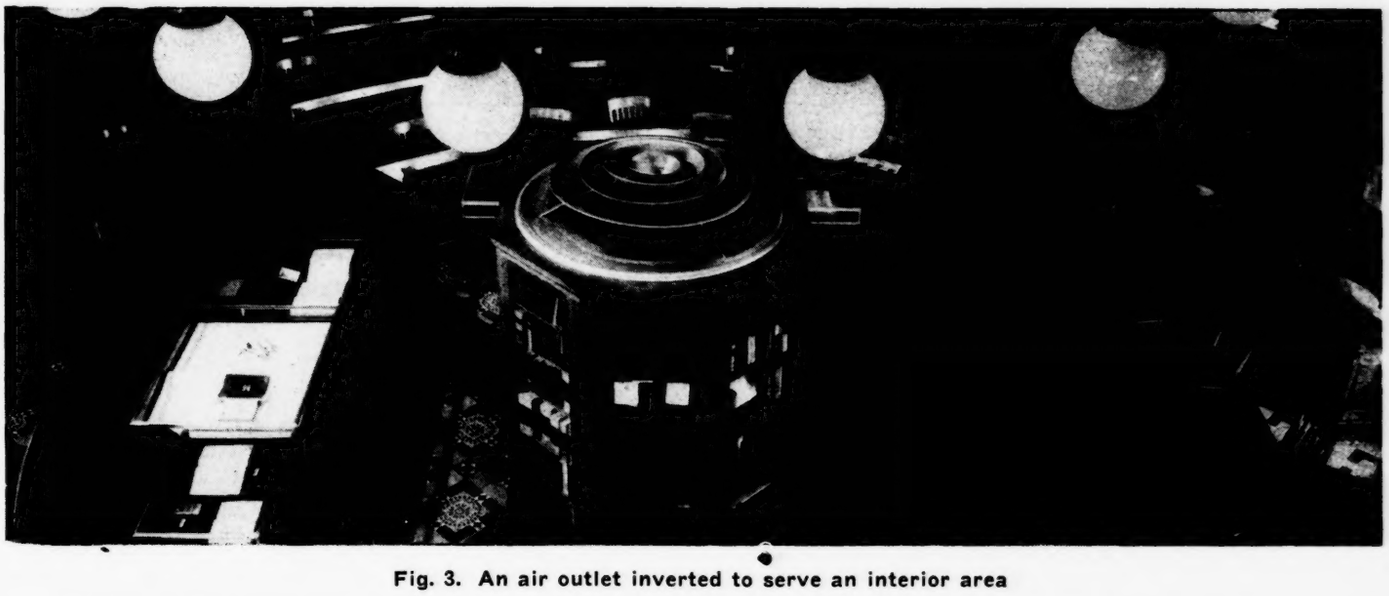


Fig. 3. An air outlet inverted to serve an interior area

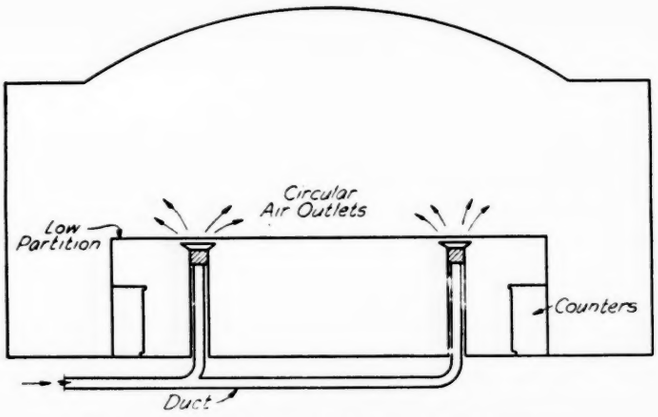


Fig. 4. Inverted air outlets for interior areas

tection against dirt, but where removed for open display, the extent of soilage will be revealing unless some form of electrostatic filter is used. One thing usually lost sight of is that merchandise displayed under glass must occasionally be shown to a customer on a counter which most likely is dusty.

Cleaning the Ducts

Dirt has been found at least two inches thick in return air ducts. In large department stores it may cost $10,000 or more to clean out these ducts and upon occasion a new system might be installed at no greater expense. Return air ducts get the dust produced within the building before the air is returned for filtration. They collect mainly lint which can become a fire hazard. Those with leaks lose suction and become good collectors. The slower the velocity in the ducts, the more they can settle out the dust. Changes in velocity, turns and like conditions, together with insufficient filtration, all serve to increase the deposit of dust in the return air system.

Return air inlets when near the floor are more accessible for cleaning. In this location they collect dust more readily but this is not a disadvantage, for the dirt and lint are better collected near the floors than in the ducts. Where inlets at the floor become blocked, or drafts are caused on those nearby, they become objectionable; otherwise, they are where a lint screen can be used and are readily cleaned as conditions require.

A low velocity or settling chamber back of the inlets would seem desirable. A low resistance throwaway type of filter section might even be used. The added resistance of a filter increases the cost for electricity to run the fan motors, but this should be less expensive than the cost of cleaning ducts. For example, a filter section is sometimes installed in each transom exit for air from laboratory rooms, to prevent the bacteria of one laboratory room from traveling to some other laboratory room. In the final analysis, the resistance for the fan motor to overcome is the same whether a single filter or 2,000 filters are used. So the energy expended approaches zero and becomes negligible as the number of filter sections increase.

Ducts should be cleaned before higher velocities are used within them—a condition that occurs where the fan capacity is increased; otherwise the ducts will clean themselves in an undesirable way. Access doors for cleaning should be provided at intervals, especially at turns. In any event, they are needed at dampers and other devices. They cannot be provided where ducts are piled on top of one another, and, where provided, serve no purpose if access beyond them is blocked by dampers, duct turns, or a multitude of projecting screws which hold the insulation.

Outdoor Air Required

The amount of outdoor air required depends upon conditions, although experience and practice have commonly settled upon 25% of the supply air as the more usual thing. Each installation must be checked, of course, against toilet and other exhaust requirements, then an amount of outdoor air should be added over and above these requirements to keep the conditioned space under a slight pressure. During the Christmas shopping period, the heat load from people and lights is at a maximum and during this time the greatest quantity of outdoor air is required. As this is the time when lowest outdoor temperatures prevail, it is not desirable to overdo the amount of outdoor air used because the required size of heating coils becomes very expensive.

The amount of outdoor air required also depends upon the number and class of people, the kind of occupancy and the size of the space. Since the internal heat load of stores is very great, the percentage of 25% for the outdoor air is usually sufficient for most contingencies. This is the minimum setting for the outdoor air damper, so that most of the time a much larger quantity of outdoor air is brought in. In some areas with extremely high internal load, this 25% will give more outdoor air than is required. It should be

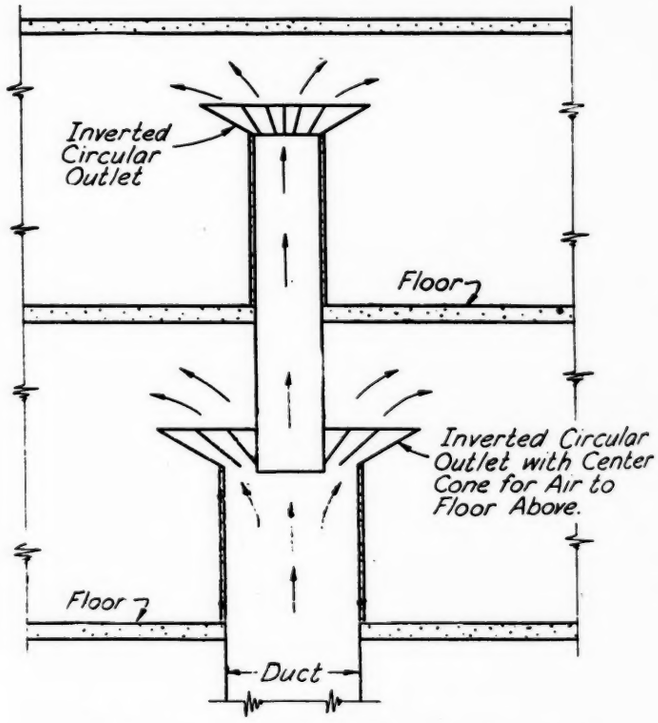


Fig. 5. Inverted outlets and use of center cone for interior areas

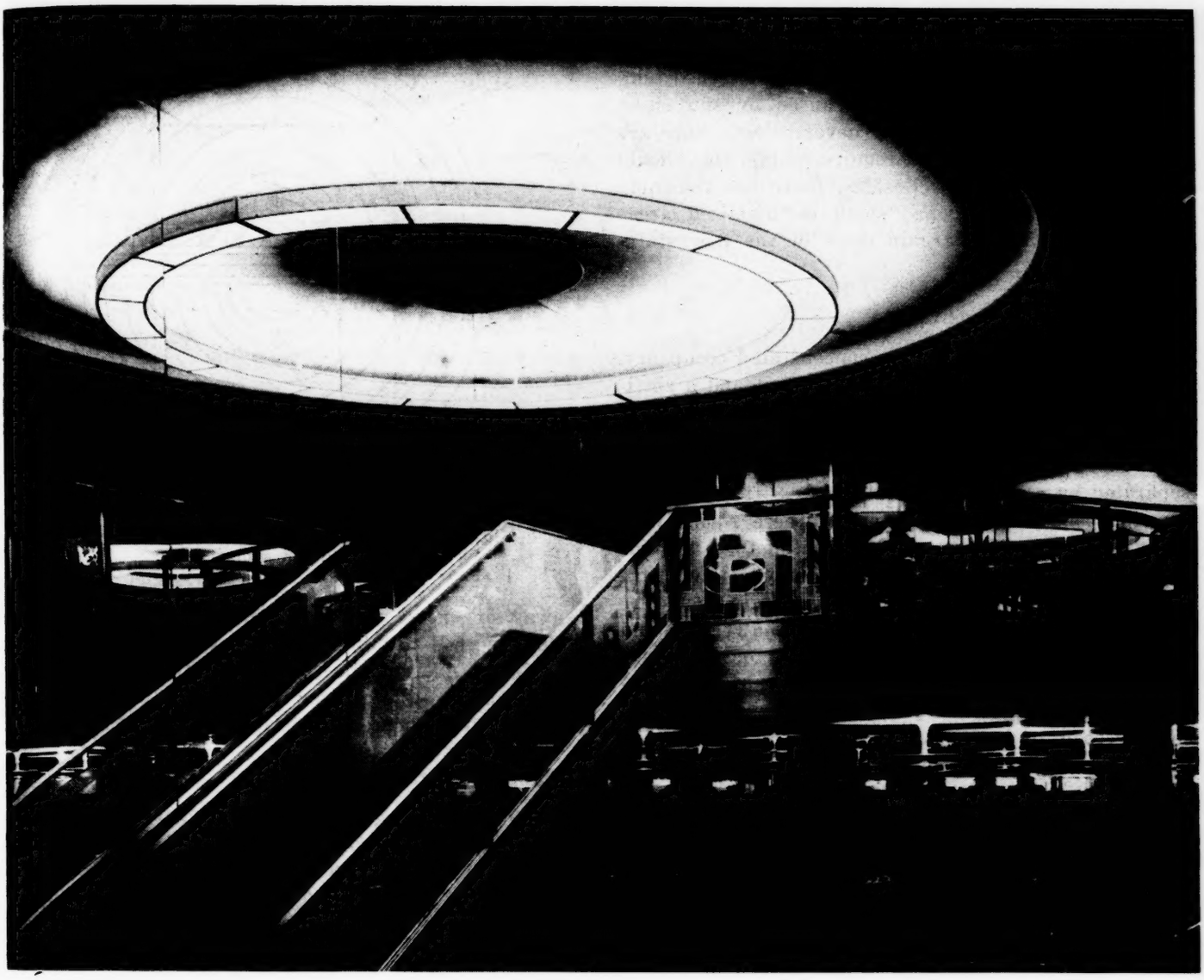


Fig. 6. Half an outlet reflected by mirrored wall to appear as one circular outlet

kept in mind that under certain conditions the nearest outlets to the fan are likely to discharge stratified air —that is, air that is not well mixed, but is mainly either outdoor air or recirculated air.

Maintaining Proper Temperature and Humidity

It is not so difficult to settle upon and hold the proper temperature and humidity conditions within a conditioned space as it is to deliver the air with good diffusion and without objectionable drafts. The air distribution system is the most important, yet most interfered with part of the air conditioning system. Research and practical experience have long established the conditions most generally satisfactory to customer and employee alike as 78 to 80F with 50% relative humidity.

Temperatures above 80F have not been satisfactory while higher humidities tend to make odors noticeable and make necessary a greater quantity of outdoor air for odor dilution. Too low a temperature is not desirable since it is no longer necessary to impress people that the store is air conditioned. The paramount thing is a system that works—one that is not so much comfortable as it is definitely not uncomfortable. Comfort should not be stressed to the customer, rather he should be unaware that the air conditioning system exists.

The temperature differential between indoors and outdoors as the weather changes has often been stressed as of greatest importance. In department stores, however, it is impossible to have the temperature indoors change to the same degree as the outdoor temperature. The heat storage of the building simply does not follow the predictions made. It is much more desirable that a temperature be held at which customers do not perspire. So called "temperature shock" is merely an awareness, as one enters, that the place is cooled, often a great relief, then shortly one feels warmer and the air conditioning is forgotten altogether.

Zoning the System

The air conditioning system needs proper zoning, constant seasonal air volumes, and neither over nor under blow. It does not need zoning to the same extent as in former days, due to the tendency to use less windows and to close the outside perimeter of stores with show windows and stock rooms. There is

a definite decrease in the use of daylight and an increase in the use of artificial light. Double and triple glass and the use of shade screens have lessened temperature differences, otherwise caused by sun effect on the various outside walls; nevertheless, there are still a number of areas that require zoning. One should at least zone by floors. Besides, there are the lamp department, fitting rooms, small sectionalized areas and the crowds on bargain days in the downstairs store.

Fitting Rooms

Fitting rooms have a more concentrated occupancy. Some have windows subject to sun effect and a shifting load condition, and possibly require heating in the morning and cooling later. The sun effect cannot be diffused to the larger areas from which the room is separated by a partition usually only 8 ft high. Customers spend considerable time in these rooms with their complete enclosure and low ceilings, so in some installations it may be advisable to supply them with practically all outdoor air. The supply air should be at a temperature a few degrees higher the year around than the other cooled areas. This calls for zoning or a separate system, but zoning may be avoided in some cases by using glass of low thermal conductivity, a shade screen, or both.

A small air outlet, arbitrarily designated herein as the half moon type, may be used for fitting rooms, so as to supply as little as 25 to 50 cfm of air per outlet. This small outlet was developed primarily for aeroplanes.

Show Windows

Show windows usually have a marquee which reduces the sun effect and prevents the fading of merchandise. The heated air is exhausted from these spaces by fans sometimes thermostatically controlled to prevent sprinkler heads from opening. Make-up air for the air exhausted is best obtained from the throw-

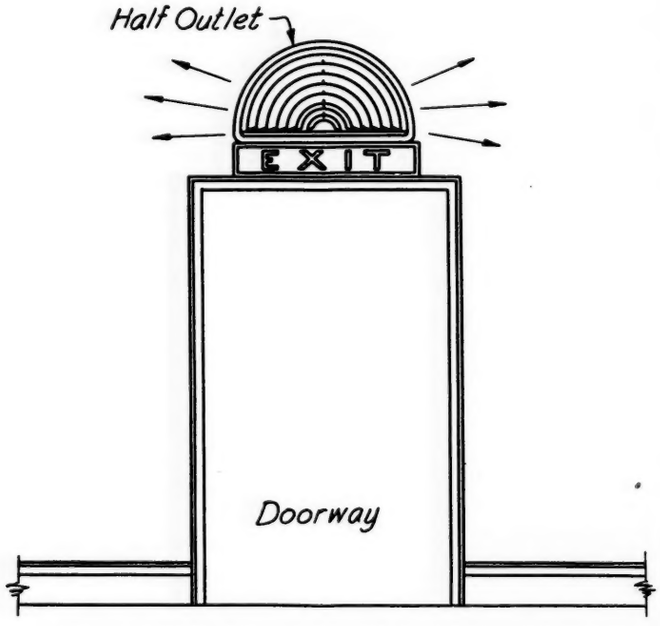


Fig. 7. Combining an air outlet with an exit sign

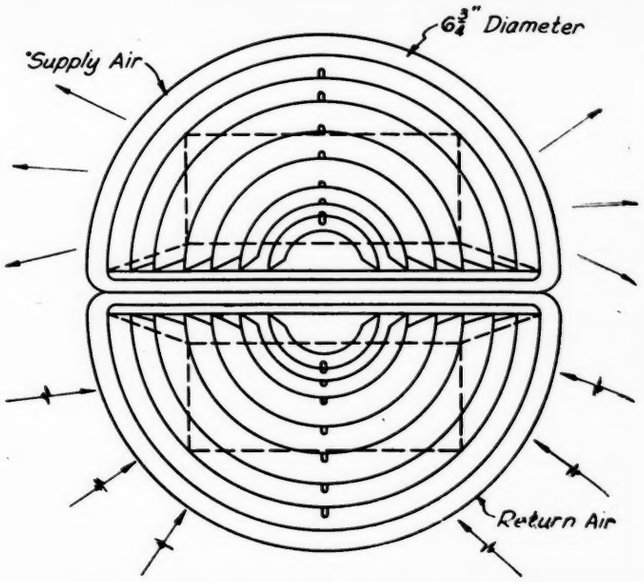


Fig. 8. Supply and return half outlets combined to form a circle

away or excess air of the air conditioning system. This method usually is sufficient to prevent spoilage of display merchandise by excessive perspiration from the hands of the window trimmers. It also provides comfort for them and increases their efficieney.

Designing for the Future

The design of the air conditioning system, whether central or unit type, should be such that the greatest possible usable floor area is obtained, yet keeping in mind the law of change and the future. Duct arrangements should be flexible, run so that a minimum of changes will have to be made, and placed where branches can easily be extended to small areas which may develop. A good record of concealed ducts should be kept and maintained as changes are made.

Duct velocities should have, in so far as space permits, a sufficient reserve for the greater capacities that they may later be called upon to handle. Lower velocities serve meanwhile as a safety factor and require less power at the fan. It is always tempting to speed up velocities in existing ducts to meet an additional load, but where these have no reserve capacity there is apt to be noise and the blowing out of the dust within the ducts as well as drafty conditions. Almost anyone will complain more about drafts than they will about either low or high temperatures.

Chilled water lines and all other parts of the air conditioning system should have a reasonable reserve capacity. Non-selling areas, offices, work rooms, store rooms and certain floors or areas may not now be air conditioned, or even so foreseen, but the modern tendency is to condition 100% throughout. Air conditioning rooms and chilled water risers should be placed on outer walls which are fixed in permanence by the streets they abut.

Where well water is available at 50F and raised to say 60F in the cooling coils, additional refrigeration, if ever required, can be economically obtained by routing the cooling water to the condensers of new compressors. From there it can even be routed to the

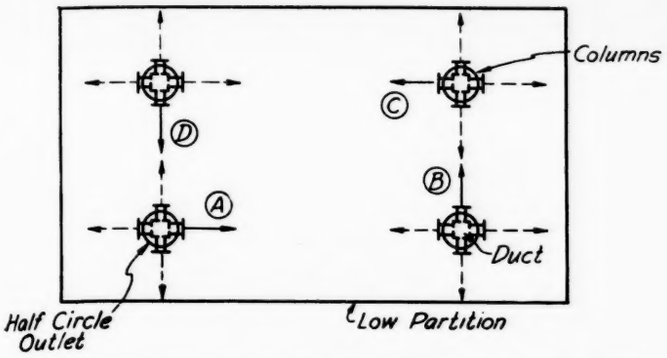


Fig. 9. An arrangement of half outlets in an interior area which required correction

condensers of steam turbine drives, to the boiler blow-off tank, or to the house service system. One installation routes the water from the coils and air washers to the steam jet refrigeration condenser, and also utilizes the well water risers to take off fire departmental hose connections at the various floors.

The Diversity Factor

Sometimes the diversity or load factor of an air conditioning system is depended upon as a reserve to obtain additional capacity. This would be where the refrigerating apparatus has been previously installed on the basis of the sum of all departmental peak loads. The diversity factor or actual load in service, however, is often taken as 80% of the peak loads when sizing the refrigerating apparatus, in which case there is no reserve for the future. The percentage that should be used depends somewhat on the type of system, method of distribution and control, and the importance of sun effect on the particular structure.

It should be remembered when establishing the actual service load that while the outdoor air load may vary from time to time and the population load may shift from one department to the other, the lighting load remains practically constant and therefore this particular load has no diversity.

A small department store—say one of three stories in height—cannot have much diversity, since there are escalators to all floors and less places for population to shift to. In any event, there is no particular gain to be made when buying refrigerating capacity by paring to the bone, for additional capacity can be bought much cheaper per ton of refrigeration with increase in size of equipment; in fact, it is relatively but a slight expense to add an ample reserve beyond the sum of all peak loads.

Traffic Counts

The population load is often based on management traffic counts within the store, and the instantaneous population is supposed to be 10% of the total tally of any day regardless of the season. Buyers and merchandising staff have various ideas as to the population and sometimes on tallies it is not surprising to find that quite some thousands of people have been lost in the store, the figure being often the difference between tallies of the in and out population.

The problem of just how to heat large quantities of cold air which rush in through the outside doors of some stores during business hours is not so easy to solve where this condition already exists. As a rule, such stores will be found to have a much greater air exhaust than they have of supply air; particularly is this so in the downstairs store.

In a new building one can design to overcome, substantially reduce, or entirely eliminate the stack or suction effect within a tall building. This is a better method than trying to heat instantaneously a gale that blows in for 40 ft or more to produce a drafty condition in a floor area so valuable for sales purposes.

Quite often it is impossible to pressurize the vestibule by special vestibule fans to offset the inrush of air. Such air has to be heated at considerable expense to a fairly high temperature because of its motion or draft. Where it is possible to achieve this, it results in blowing a lot of heated unfiltered air well back in the store and does this in an area from which the designer is trying to remove heat.

Leaky unused elevator shafts and doors on all sides of the building add to the difficulties. Though glass shields at counters, glass doors at departments and electric heaters back of counters all help out, they are but feeble attempts to overcome the complaints. Storm doors and additional vestibules are of greatest help, although these are usually considered as a customer hazard.

Ventilation Versus Air Conditioning

Where the hotter days and season are of shorter duration there are still some stores which rely only upon simple exhaust fan ventilation for comfort. The power for the fans is not too expensive, but the results

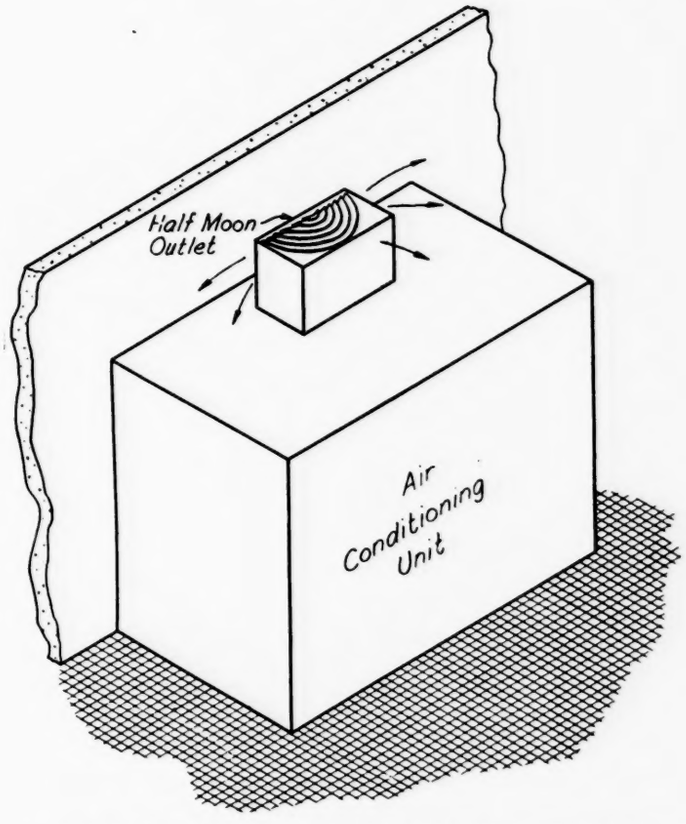


Fig. 10. A half outlet as used on the discharge of an air conditioning unit

obtained in the way of cooling comfort are less than half way measures and there is discomfort from cold drafts in the intermediate season when fans must still be run, and of course there is a maximum of dust. Ventilation (except for limited areas which require exhaust for various reasons) if used at all, should be by means of supply fans, so that the incoming air to the fans can be filtered and the dust produced indoors partially exfiltrated rather than infiltrated. This usually requires additional expense for a system of ducts.

Supply air can be made directional, but exhaust fans, of course, take air from any of all radial directions, or through some line of least resistance; furthermore, air is quite likely to be short circuited from some nearby window without benefiting anyone, or hot air may be drawn in from some other area of the store. This may make one space comfortable and some other place uncomfortable.

In larger areas it is futile to expect that the air from window fans as blown in on one wall will traverse the space to the window fans on the opposite wall and there be exhausted. Even if this were possible, it would only result in the air picking up so much heat on the way across that conditions along the exhaust wall would be very uncomfortable.

Where the night temperatures are considerably below the maximum daytime temperatures, some cooling can be effected at small cost by operating large exhaust fans during the evening hours. The heavy walls, columns and furnishings can in this way be cooled down close to the outdoor night temperature by morning opening hours and so provide a large storage for the heat absorption of the following day. Exhaust fans, however, should never be run at night where there is an air conditioning system.

Every means that is practical should be used to prevent heat from entering the building. Shade screens will stop much of the heat inflow and cost less than power and investment costs for fans to remove an equivalent amount of heat.

Costs

Store management, long accustomed to the pooling of merchandising information, often looks to other store managers for a standard or least expensive plan, or the one best method of air conditioning, but there can be no set approach nor single plan for production assembly in all stores. It's all a matter of engineering to suit the installation and the needs of the particular store in question. Available space for equipment and ducts, store arrangement and decorations, possible future extensions upward or outward, and the need for compromise with inherited utilities are some of the variables.

The relative cost of a structure has gone down while the cost of an air conditioning system has gone up. Therefore, the air conditioning cost as a percentage of the building cost is very much higher today. Improved engineering design permits lower ceiling heights and less cubage for the structure. On the other hand, improved service and requirements for air conditioning, together with improved products for its better control and efficiency, have only served to increase the air conditioning costs. This is in line with increase in general mechanical costs as caused by better filtration, transportation, and increased lighting; and in some cases by the introduction of radiant heating. Alterations, as a rule, produce extensive and expensive mechanical changes throughout the building whereas the structural changes are generally more localized.

It should be emphasized that the decreased cost of a structure having less cubage has only been made possible because of the air conditioning system. Old-time stores had high ceilings because they lacked air conditioning and quite often even a ventilating system. In Cuba, for example, ceiling heights in hotels and other public places can be reduced from 5 meters (16 ft) to 3 meters (10 ft), provided they are air conditioned. The air conditioning system should be duly credited with this saving in the cost of structure.

Costs should be based upon net air conditioned area, which means that the stairways and columns are not included. As a rule, this net area is from 80% to 85% of the gross area. The cost per square foot of area is, of course, proportionately less as the area increases, so that there can be no hard and fast rule. Such rule of thumb cost ratios are only rule of thumb and seldom take in account the cost of changes for plumbing, electric, steam, sprinkler and redecorations.

Cost of insulating ducts can sometimes be reduced. Where a duct is run through conditioned areas it is only on a long uninsulated run with considerable duct perimeter that down near its end the air may be delivered at too high a temperature. In such cases the air within the duct is progressively raised in temperature as it travels along, in this way producing an inequality of cooling throughout the conditioned spaces. This is particularly so when the air leaving the fan is at such a low temperature that it picks up more heat and so establishes a greater temperature differential between the beginning and end of the duct.

In the south where an air conditioning system runs the year around an economical contract with the local power company may provide for a time clock which will automatically shut off power at 5:30 p. m. The only drawback is that sometimes it is desirable to keep the store open for a night rehearsal, a fashion show, or for sales around Christmas time.

Radiant heating does not seem to be justified for most stores, though there may be some stores where a

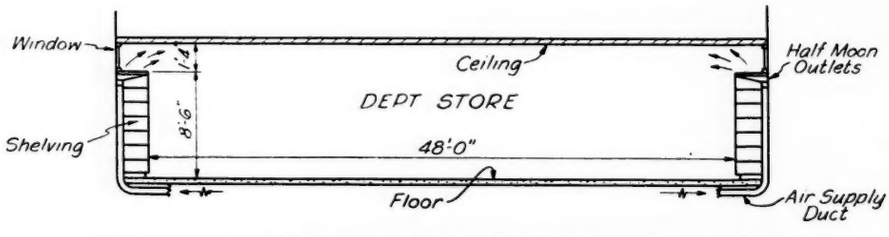


Fig. 11. Using half outlets to supply a space having no hung ceiling for ducts

limited application could be made. The interior of a store produces and provides its own heat while the areas which follow the outside walls are usually only service areas or stock rooms. Radiant heating has the advantage of presenting a wall free from projecting mechanical contrivances, a thing which is of no great merit where service areas are concerned. In mid-southern climate there are only a few days where the outside walls of a store will be very cold; furthermore, the inside temperature of an exterior wall can always be substantially raised by insulating it.

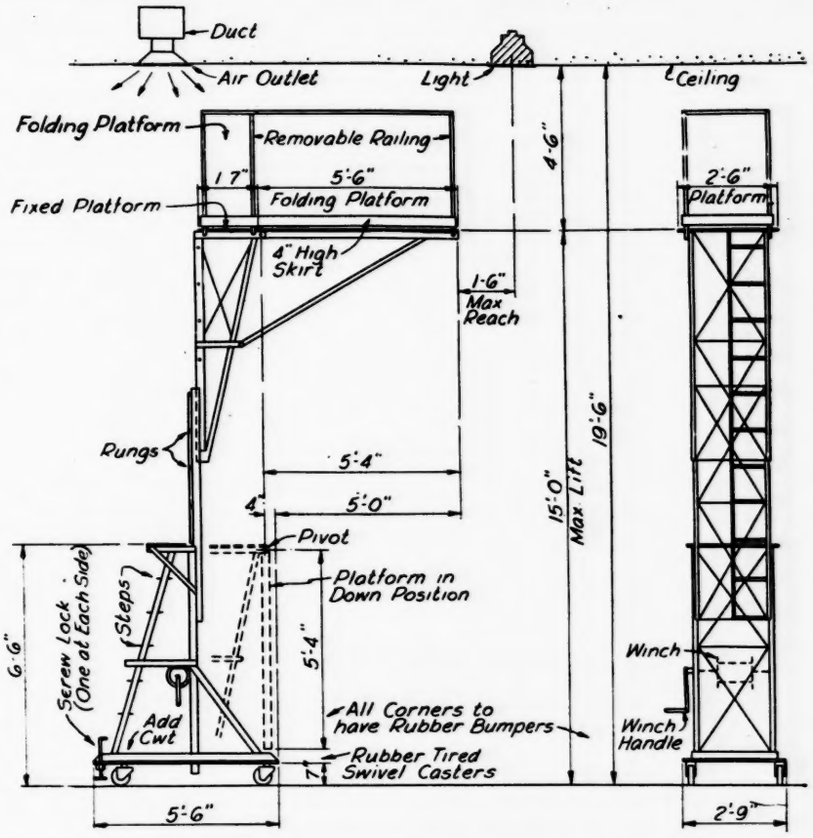


Fig. 12. A movable telescoping scaffold for servicing lights and air outlets

Maintenance

Sometimes it is a problem to readily reach the lights and adjust the air outlets on the high ceiling of the ground floor. A device for doing this is shown in Fig. 12. Similar devices are standard on the market, but the particular one shown has been modified so that the overhead scaffold extends beyond the base frame. This allows servicing over sales counters and other fixed obstructions.

The platform folds, a hand winch is provided, and the device telescopes so that it will clear a door 6 ft 8 in. high, thus allowing it to be kept outside under a weatherproof cover. Counter weights can be added as shown to prevent overbalance, though some clamp the base directly to floor attachments. A screw lock is necessary to prevent swivel casters from turning. Changes from the given measurements can be made within limitations.

Satisfactory operation of the air conditioning system depends more upon the man who supervises the maintenance than it does upon special controls designed to reduce the amount of supervision required. Controls are good when well serviced but the better the supervision the less they are needed. Furthermore, fewer controls call for less maintenance. An interested operating engineer of but little experience is usually better than a disinterested engineer of considerable experience.

A schedule should be drawn up for the general inspection of compressors, removal of condenser and cooler heads (for cleaning and checking for leaks), renewal of fan belts, and the inspection, repair and lubrication of fan bearings. Pumps sometimes require new rings and shafts, dampers stick or move improperly because they are not oiled and rust up, boilers must be cleaned and serviced and chimneys vacuum cleaned. It is better to prevent breakdowns than it is to service equipment afterwards.

Thermostats require cleaning and occasional repair, while compressed air lines for controls should be kept free from moisture. Fan wheels and casings will corrode unless cleaned and repainted as required. Tanks, spray nozzles and cooling coils of dehumidifiers should be cleaned and flushed and upon occasion the cooling towers and evaporative condensers also require cleaning. Maintenance will be greatly facilitated and made readily possible where sufficient space has been left below the ceiling in which to get a block and tackle over the coils, compressors and like apparatus. Floor drains should be conveniently located to take the spill of water from parts when removed.

Duct Shape

From time to time slight changes in the routing and shape of ducts are required. When making such alterations the maintenance engineer should remember that ducts of the same area do not have the same frictional resistance to the flow of air. For example, a duct of 18 in. $\times$ 18 in. size cannot be changed to a 40 in. $\times$ 8 in. and still obtain the same results. While both have the same area, the 40 in. $\times$ 8 in. duct has much more perimeter or surface against which the air rubs. To obtain no greater resistance a 46 in. $\times$ 8 in. duct would be required. Tables for equivalent resistance in ducts should be consulted in each case.

Some stores clean their filter sections in accordance with a regular schedule, though an accurate check can be kept on the necessity for cleaning or replacing the ordinary type of filter sections by installing a draft gauge at each filter. As the filter resistance builds up, its efficiency increases, due to dust on the filter catching more dust. On the other hand, less air will be passed through the filter, and as a consequence, efficiency is obtained only at the cost of delivery.

As for the painting and cleaning of the walls, lighting fixtures, etc., this is a task that has been greatly reduced over former requirements due to improved filtration.

Lubricants for Refrigerator Compressors

F. L. JOHNSTON
Products Application Department, Shell Oil Co., Inc.

The characteristics of lubricants for refrigeration applications are discussed with respect to temperature, viscosity, refrigerant solubility, flash point, etc.

FOR years, chemists and engineers at our Wood River, Ill., laboratories have been conducting research on lubricants for refrigerator compressors. Their aim has been to keep abreast of all mechanical developments in the field, and to improve lubricants constantly to meet the highly specialized and ever changing requirements of refrigerating equipment.

Out of this research has come a well-rounded knowledge of the most important properties a good refrigerator lubricant must possess. There are six of these in all.

(1) An oil should have maximum stability against deterioration in service.
(2) It should not foam excessively under conditions of use.
(3) Its viscosity index should be the highest practical, whether the oil is soluble in the refrigerant or not.
(4) The pour point of the oil-refrigerant solution should be lower than the lowest temperature of compressor operation.
(5) There should be no hard wax separable from the refrigerant-oil solution that will be solid at the highest normal temperature of operation.
(6) None of the oil should volatilize appreciably at the highest temperature of compressor operation.

While it has been possible to isolate and define these essential characteristics of a good refrigerator lubricant, it has not yet been practical to manufacture one oil that will give best performance in all units under all conditions of operation. Different lubricants must be selected for specific applications, depending on the requirements of the various units under varying operating conditions.

Refrigerator Parts and Processes

Of the four integral parts comprising a mechanical refrigerating unit—the compressor, the cooling unit, the mechanism to control the release of the compressed refrigerant, and the chamber or coil for absorbing heat from the refrigerated area—only the compressor requires lubrication. Since all four parts are in the same system, however, all may come in contact with varying amounts of oil, and all must be considered in selecting the proper lubricant.

The most common types of compressors are the piston, rotary and impeller. The first two are positive displacement types, and normally have small clearances between the moving parts. The second, which usually has the smaller clearances, is the type used most frequently in smaller units.

Controls for releasing the refrigerant may be of the float feed, pressure actuated diaphragm valve, or fixed orifice types. The first two provide for intermittent expansion of the compressed refrigerant, and the third sets up a continuous process.

Consideration must be given also to the types of refrigerants used when selecting the proper lubricant. The common types are the Freons and other organic halides, ammonia, carbon dioxide and sulfur dioxide.

During their years of research on systems using these and other processes and parts, Shell engineers encountered a wide variety of mechanical, chemical and lubricating problems, all of which are closely interrelated. For instance, there is binding of parts. This is caused by lacquer, sludge, rust or deposition of metal from other parts of the system, and may occur in compressors with small clearances. Then there is corrosion, which may interfere with the operation of the compressor parts. Excessive oil deposited on the walls of the expansion chamber may retard heat transfer, the expansion valve may become plugged by wax from the oil or by extraneous materials such as ice, or the drag in the compressor may become excessive at low temperatures.

The discussion which follows covers the six properties of a refrigerator lubricant, previously listed, which are necessary to overcome or forestall such problems as these, and to provide the most efficient lubrication in today's refrigerator compressors.

Stability Against Deterioration or Change

Many operating difficulties are caused by the chemical interaction of the oil, extraneous materials such as water and oxygen, the metals of the system, and the refrigerant. While such difficulties are not necessarily related to an oil's stability, this is the oil property most often involved either directly or indirectly.

Water and oxygen play particularly important roles in these problems. The presence of one or both of them is necessary for any of the chemical reactions that cause trouble. For this reason, most manufacturers try to keep them to a minimum in their units, but it is almost impossible to seal a unit without including traces of them. Even if moisture could be completely eliminated in the original system, the reactions of oxygen with the oil would result in some water formation, and oxygen may be introduced in minute quantities in solution, either in the oil or the refrigerant. Furthermore, when a unit is serviced in the field, it is impractical to use the complex methods

required to remove these materials before the unit is resealed.

Metals of the system are important, too. They sometimes act as catalysts in promoting oil deterioration, and then oil deterioration products can attack the metals and cause operational troubles. The nature of such deterioration products depends on many factors.

Upon oxidation, oils with high aromatic compound contents are most prone toward sludge and lacquer formation. The presence of water greatly accelerates this development. In systems using sulfur dioxide, for example, this material will combine with water to form sulfurous acid, and if oxygen is present, sulfuric acid. Both these strong acids may attack the oil directly to form sludge and lacquer which will bind the moving parts in piston and rotary compressors because of their small clearances.

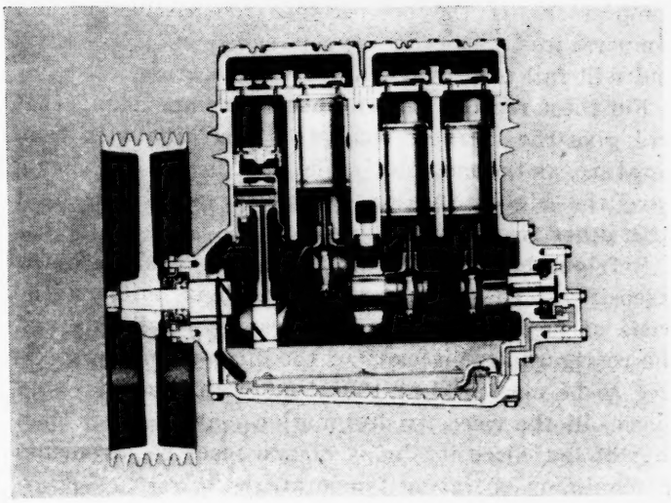
In more highly refined oils, from which most of the aromatic compounds have been removed, oxidation does not result in the formation of much sludge or lacquer because most of the deterioration products are oil soluble. *But*, whether the oil is highly refined or not, some of these deterioration products, which include peroxides, alcohols, esters, aldehydes, ketones, carboxylic acids, water and carbon dioxide, may affect the metals. In many cases, rust or chemical corrosion may be attributed directly to them, and in others to compounds formed by reactions between them and the refrigerant.

For instance, four types of reactions may result from water and refrigerants: (1) carbonic acid, which can corrode or rust metals, especially iron, may form from water and carbon dioxide; (2) ammonium hydroxide, especially active toward copper and brass, may form from water and ammonia; (3) sulfurous and sulfuric acids, active toward most metals, may form in the manner already described; and (4) halogen acids, that will also attack most metals, may form from the hydrolysis of organic halides.

A problem unique in the rotary compressor is that copper, removed from lines or other sources, may be deposited on the slide valve mechanism and plated to such an extent that it binds. Clearance on these may be as little as 0.0001 in. This phenomenon may occur in other types of compressors as well, but since the clearances are generally greater, the problem is less critical. Whether the copper passes through a soluble or colloidal stage, or both before deposition, is not known. It is known that processes which attack copper finally lead to this result. Since the rotary compressor is most commonly used with methyl chloride or Freons, it is important that their hydrolysis be prevented.

The most practical way to forestall problems such as these is to increase an oil's stability against deterioration, thus preventing the formation of undesirable decomposition products. This can be done effectively by adding a suitable anti-oxidant to a highly refined base oil. A properly manufactured oil will offer outstanding stability in the presence of all metals under a wide variety of operating conditions.

In the final analysis, each type of refrigerating unit must be considered individually. Just as most manufacturers take into account the susceptibility of various metals to different refrigerants in planning their units, as for example, avoiding the use of copper in ammonia compressors, so must oils be designed to meet special requirements.



Cutaway view of Frigidaire 4-cylinder compressor.

The Use of Alcohol

The practice of using alcohol to service refrigerating units in the field is also related to an oil's stability. While alcohol is used to prevent the formation of ice from traces of water entering the system when it is opened, it frequently causes additional troubles of its own. Its chemical effect on a refrigerating system is similar to that of water.

To avoid this additional aggravation, fixed cartridges of a desiccant material (calcium sulfate, silica gel, etc.) are commonly used to insure dryness. These are quite satisfactory if properly applied.

Mutual Solubility with the Refrigerant

Both carbon dioxide and ammonia have negligible solubility in lubricating oils.

The Freons and methyl chloride have high oil solubility and systems using them are designed with this fact in mind.

In sulfur dioxide units, the mutual solubility of refrigerant and oil is dependent upon the oil's characteristics. Oils of low aromaticity usually have low miscibility with sulfur dioxide, while those high in aromatics are more soluble. Since sulfur dioxide has a higher specific gravity than oils, any of it that liquefies in the presence of a nonsolvent oil will form a lower layer. In most sulfur dioxide units, however, the construction is such that the refrigerant is not liquefied in the oil chamber. In these systems, low solubility in oils is desirable to prevent foaming in the oil, with oil carry-over.

In both sulfur dioxide and Freon units, the accumulation of foam sometimes results in free oil in the compressor. For these units, Shell engineers recommend an oil with a minimum tendency toward foaming.

It is important that the oil have sufficiently high viscosity at the highest temperature of operation to provide for efficient sealing and lubrication in the

compressor. If the oil becomes too viscous at low temperatures, however, it can cause excessive drag and will fail to provide the best lubrication.

For these reasons, our engineers recommend oils that will give the smallest change of viscosity with temperature, as the most desirable; that is, the oils should have the highest possible viscosity index consistent with other requirements.

Refrigerator manufacturers usually designate the viscosity of the oil to be used in their units on the basis of mechanical design, operating conditions and the refrigerant. Viscosity of the oil is normally specified to be measured at 100F, but with high viscosity index oils the viscosity designation may be lower than that of low viscosity index oils to meet requirements at maximum operating temperatures.

With refrigerants that are insoluble in oil, the latter's viscosity can be predicted at any temperature above its pour point by the ASTM viscosity-temperature charts, if the viscosity is known at two temperatures.

With refrigerants that have high lubricating oil solubility, the oil's viscosity is reduced in service and the oil should be selected accordingly.

Pour Point

In any type of operation, oil will not provide efficient lubrication or allow efficient mechanical performance if it solidifies. Pour point is simply an indication of the temperature at which the oil changes from a liquid to a semi-solid state.

With oil insoluble refrigerants, this factor is of paramount importance in relation to the lowest oil temperatures encountered during operation.

With oil soluble refrigerants, however, such as Freons and methyl chloride, there is no danger of the oil becoming solid even if temperatures far below the lubricant pour point are encountered. These refrigerants automatically lower the pour point.

If there is oil carry-over in compressors using such refrigerants, however, oil may be deposited in the expansion unit. This will result in decreased cooling efficiency if adequate provision is not made for returning the oil to the compressor.

Our engineers recommend that the pour point of the oil or its refrigerant solution should be lower than the lowest temperature of compressor operation.

Wax Formation

Another factor to watch in oil soluble refrigerants is the formation of *hard* wax in the refrigerant-oil solution.

The word, "wax", commonly associated with paraffin, has come to mean a hydrocarbon material that remains solid at room temperatures or higher. Strictly speaking, however, several types of wax can be obtained by what might be called a "fractional dewaxing" of an oil.

The hard and crystalline material that comes out first is the type with which we are most familiar. Once separated from oil, it will not melt or be dissolved easily until it reaches temperatures higher than those normally found in a refrigerating unit.

The melting point of the wax that comes out next is much lower, and even in the solid form it is softer. It is less easily separated from oil, and even if its separation occurs, it is more easily melted and redissolved. Consequently, it represents a much less serious hazard than the first type.

The problem involved here is the possibility of plugging the expansion orifice or feed control valve to the evaporator. If the first type of wax is deposited in these units, especially in an orifice, it may form a hard cake requiring manual removal before efficient operation can again be obtained. If the second type is deposited, the pressures developed are normally efficient to remove it. In any event, the deposit softens with a slight rise in temperature, and so becomes important only when very low temperatures are used continuously.

All hard or potentially troublesome wax should be removed from refrigerating oils. Oils which are not dewaxed, even though they are of low pour point, contain hard waxes which may cause difficulties.

Cloud Point

Cloud point indicates the temperature at which wax precipitation begins in the oil. In systems using oil insoluble refrigerants, this property is important since it indicates the temperature at which oil forms potential expansion valve clogging materials. Its importance in other systems depends on a number of factors already enumerated and discussed in regard to pour point.

Flash Point

Flash point is related to the vapor pressure of the lighter fraction of the oil. Although normally of little significance in refrigerator oils, it can be an important factor in indicating contamination of new oil, and is also important when relatively high temperatures are encountered in the compressors of units demanding low viscosity oils. When an oil of low flash point is used in a system that operates with a high compressor temperature, a small part of the oil may be vaporized and carried over into parts of the unit where it is not desirable.

Shell engineers recommend refrigerator oils with high flash points for the respective viscosity grades, oils that are non-volatile under conditions encountered in any normal service.

The conditions under which refrigerator compressors operate and the mechanical refinements made in them to obtain the utmost in performance, life and efficiency have resulted in highly specialized lubricant requirements. Years of laboratory research and development, however, combined with extensive field tests; have enabled petroleum engineers and chemists to produce oils for refrigerator service whose composite properties make them well equipped to overcome the problems discussed in this article. No matter what type of compressor a system uses, what type of refrigerant or control to release the refrigerant, or what the operating conditions are, there is now an oil to meet each particular need.

Radiant Heat for a New Airplane

THE new Douglas DC-6 has a complete year-around air conditioning system. The big, four-engined airplane has a cooling system for warm weather, and for cold weather a Janitrol aircraft heater provides heat for a radiant panel heating system, with ventilation and humidification added. By devising a method of providing these two additional comfort features, Douglas has been able to humidify and ventilate the space being heated and has retained all the advantages of a radiant heating system.

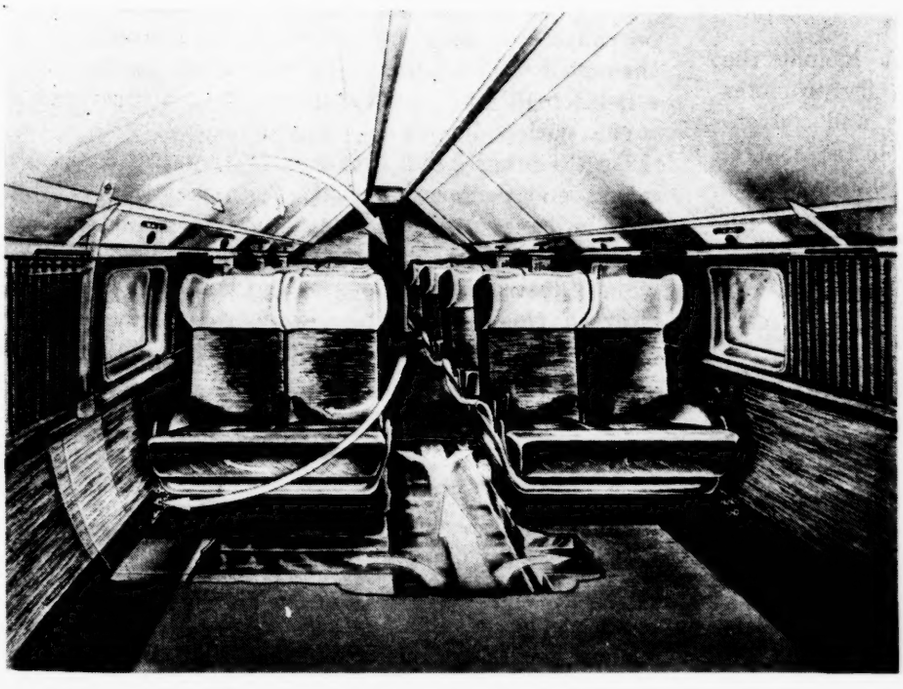
The new Douglas adaptation of radiant heating is accomplished by using warmed outside air in the distribution system and circulating this same air in the cabin, in the manner shown in the accompanying sketch of a DC-6 cabin interior.

A supply duct running the full length of the cabin under the center aisle carries outside air and heated air from the combustion heater blended at a maximum temperature of 85F. Ducts branch off from the main duct to side panels at every seating section. Cabin floor plates form the tops of the floor ducts. In this way a large portion of the cabin floor is radiant, thus eliminating cold floors. The branch ducts carry the heat to panels between the outer skin and the cabin. Passengers sitting in seats by the window would frequently be uncomfortable because their bodies would radiate heat to cold walls were it not for this panel heating method.

The tempered air which has provided the warmth for radiant heating through the duct and panel system becomes ventilating air as it is discharged from the panels at a point just below the hat racks in the cabin. Since the ventilating air has a velocity no greater than 35 fpm where passengers are located, its movement is imperceptible and passengers are not exposed to drafts. Cooled air is distributed through the same system in warm weather. The ventilating air leaves the cabin through grilled openings in the side-walls near the floor of each outside seat. On sleeper planes, a special duct system is used to discharge overboard the spent air from each upper and lower berth.

The heater supplying cabin warmth operates only when air pressure from the supercharger is at a temperature insufficient to heat the cabin. Thermostatic controls switch the heater on and off, when heat is required, to maintain a constant cabin temperature. The capacity of the heater is sufficient to hold an even 70F with an outside temperature of —40F without benefit of heat from the pressurized cabin superchargers. The same unit also supplies heat for anti-icing of the windshield and for the cockpit. A system of dampers and automatic controls makes it possible to recirculate up to 50% of the cabin air through the supply system if necessary to meet unusually severe outside temperature conditions.

Another new feature on the DC-6 of especial interest to men in the heating field is that combustion heaters are being used as standard equipment for the first time for ice prevention on wings and empennage. A Janitrol aircraft heater is located on each wing of the DC-6, just outboard of the outboard engine, and a third unit is in the rear of the fuselage and just forward of the vertical stabilizer. Cabin heat is obtained from another unit located amidship in the belly space below the floor of the pressurized cabin. Locations of the four heaters are shown in the accompanying drawing. They are especially-designed, large-capacity heaters of the same size and are interchangeable. They are designed for ram air operation or in conjunction with the cabin superchargers. They take their fuel from the engine fuel supply and have a heat output, as applied to the DC-6, ranging up to 310,000 Btu per hr, varying with the speed of the airplane and resultant ram pressure.



Cutaway drawing shows movement of warm air through main duct under cabin aisle and side ducts at each seating section of DC-6. Floor plates and side walls form radiant panels and air is released into cabin at head level for ventilation and is exhausted overboard at floor level.

The Law of Municipal Contract Liability

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Cincinnati, Ohio

Because of two legal functions of a municipality, contracts must be carefully considered. Interesting points of municipal liability are presented.

CONSIDERABLE has been written from time to time on the subject of usual non-liability of the United States government, states, counties and municipalities for injuries to persons and private property resulting from legislative or governmental functions. However, little or no dependable information is at hand pertaining to the legal variations of municipal liability to heating engineers and contractors arising from governmental or legislative, and proprietary business, ministerial, or corporate contracts and agreements. Therefore, since the higher courts recently have rendered several important decisions involving this new law, we shall review in detail these interesting cases.

First, it is well to explain that the law is well established that the functions of a governmental department, as a city, are dual in their nature. One element of such functions is governmental or legislative and the other may be termed as proprietary, business, ministerial or corporate functions. To avoid confusion of readers, it is advisable to state that proprietary, business, ministerial and corporate functions are synonymous. The synonymity of the terms governmental and legislative is apparent. The higher courts are in accord that when a city exercises functions which it is authorized to assume under the statutes of the state, the officials of the city act *for the people* strictly as an agency of the government.

For example, governmental functions include the exercise of the police power by which a city promotes or protects the general welfare, comfort and convenience of the people, maintains supervision and control over its own property, or enacts legislation under which the peace and good order of society is regulated. These functions *cannot* be delegated nor bartered and any effort to do so is unconstitutional and void. See Brenham v. Brenham Co., 67 Tex. 542; San Antonia v. San Antonio Co., 12 S. W. (2nd) 546; Nairn v. Bean, 48 S. W. (2nd) 584; and Omaha v. Omaha, 147 F. 1, 12 L. R. A., N. S., 736, 8 Ann. Cas. 614.

Obviously, when public officials or employes exercise governmental powers they are *not* required by law to exercise even ordinary care to protect individuals and corporations against injury. If a governmental department, as a municipality, can be held liable for failure of its officials or employes to exercise ordinary care when performing governmental functions, this is so *only* because *unusual* state laws have been enacted for the express purpose of preventing such governmental agencies from avoiding liability arising from governmental functions.

Exercise of Business Functions

Modern higher courts hold that a city *never* exercises governmental functions, but only proprietary or business functions, when it makes contracts for the interests of itself or its inhabitants. In other words, so long as a city does not violate valid laws it is at liberty to make contracts in the same way and to the same extent as individuals or private corporations. See Ysleta v. Babbitt, 28 S. W. 702; Green v. Amarillo, 244 S. W. 241; and Rowan, 5 Cir., 20 F. (2nd) 501.

Thus, if through even gross negligence a contractor, or his employe, is killed or injured by municipal employes who perform governmental functions, or while on property used in performance of governmental functions, the city cannot be held liable in damages. But since a municipality never performs governmental functions when making or fulfilling contracts it is liable to the same extent as ordinary individuals, if it breaches a valid and lawful contract.

In other words, although a governmental department, as a city, makes a contract to benefit its inhabitants and such contract is intended to promote the general welfare, comfort and convenience of citizens, yet it cannot and will not be classified by modern courts as involving governmental functions although, actually, it does. See City of Crosbyton v. Texas, 157 S. W. (2nd) 418.

So, therefore, it is quite apparent that an engineer or contractor may without fear of financial losses, through technicalities, make a contract for benefit of a municipality or its inhabitants, if such contract conforms with valid laws.

On the other hand, it is certain that if a contractor makes and performs a contract in violation of state laws he cannot recover any payment for materials or labor. We shall review several higher court decisions which illustrate variations of the law on this subject, later in this discussion. However, at this time we shall continue explanations and illustrate by reference to leading higher court decisions in which engineers and contractors have successfully litigated their claims against municipalities, and other governmental agencies.

Mechanic's Lien

Contrary to the opinion of many readers, a contractor who performs a valid contract may sue and perfect a mechanic's lien against a city. This is so because modern courts are inclined to hold that every one who

by his labor or material has lawfully contributed to the preservation or enhancement of property of a city thereby acquires a right to compensation. In other words, there is no reason why a municipality, that erects or improves buildings for the use of the public, should occupy a more favorable position with respect to mechanic's liens than the citizen. As indicated, municipalities, in the creation of debts, are controlled by certain limitations defined by valid laws, but within these limits the municipality occupies toward the laborer or materialman the same attitude as the citizen.

For illustration, in City v. Ben Williamson and Co., 171 S. W. (2d) 968, the testimony showed the following facts: A city entered into a contract with general contractor to improve its waterworks system. The general contractor sublet the plumbing and heating to a subcontractor. However, the general contractor purchased some of the materials used in the performance of the contract by the subcontractor from a seller who charged the bill directly to the general contractor's account. The subcontractor also purchased the required plumbing and heating materials, used in the performance of the subcontract, from the same seller.

When the general contractor's contract was fully completed the city paid the general contractor for the performance of the contract but failed to pay the seller for the materials furnished to the general contractor and also to the subcontractor, and the seller filed suit against the city on a mechanic's lien. During the trial the seller proved that although a portion of the material was charged on his books to the sub plumbing and heating contractor, it was agreed and understood that the general contractor would be responsible for the material furnished to all subcontractors. In view of this testimony, the higher court held the lien valid and rendered a judgment against the city for the amount of the lien.

This court explained that when testimony proves that a general contractor guaranteed payment for materials purchased by a subcontractor, such general contractor becomes primarily obligated to pay for the materials and, therefore, either an ordinary property owner or a municipality becomes liable for payment of the debt.

Also, see Allen v. United States, 122 Ky. 825, where it was contended that lien creditors could not sell public buildings to satisfy their debt against a municipality, although they furnished material used in the construction and heating unit of the building. The higher court refused to agree with this contention, and said:

"To this argument we cannot assent. It is against public morals and opposed to every principle of justice and fair dealing."

And also in Hightower v. Bailey, 56 S. W. (2d) 148, the higher court said:

"One no more than the other should be permitted to secure the benefit of labor and material in the construction of useful buildings without paying for it. In fact, the municipality should be required to respond more promptly to the mandate of the law than the citizen, and held to a stricter accountability in the payment of its just and legal obligations. And where a municipality has within constitutional limits provided for the erection of a public building, and secured in its construction the labor and material of the citizens, the court will compel it to pay him."

On the other hand, all higher courts are in accord with the rule of law that irrespect of debts owned by a contractor, architect, or engineer, creditors *cannot by garnishment* proceeding secure money due for municipality. The reason for this rule of law is that if funds set apart for public construction work could be taken by garnishment for a debt during the progress of construction, this procedure may prevent the completion of the work.

For example, in Holston Union National Bank v. Knox County, 165 S. W. (2d) 382, it was shown that a bank filed a garnishment suit against a heating contractor. The higher court said:

"It is plainly to be seen that the old rule exempting counties and municipalities from garnishment is still upheld as a sound rule where 'the seizure by garnishment of a contractor's funds might prove an embarrassment to the public.' "

Ultra Vires

We have reviewed the law which proves that, under normal circumstances, either an engineer or heating and air conditioning contractor may sue and compel municipalities to fulfill the terms of ordinary building and installation contracts. Later on we shall review several more higher court decisions which illustrate unusual variations of the law on this subject.

However, at this point it is well to forcibly direct attention of readers to the unfortunate fact that unless a contract fully complies with laws and regulations no one, including heating and ventilating engineers and contractors, can receive any payment for materials and labor furnished a municipality.

The higher courts consistently hold, for example, that persons who sell materials or perform services for a state, county or a municipality are bound to know that the officials who make the contract have proper and legal authority to make the contract, otherwise the seller, engineer or contractor may forfeit his right to recover payment although the materials or services benefitted the state, county or city.

A simple illustration of this law is Ozaukee Co. v. City of Milwaukee, 9 N. W. (2d) 99. Here the testimony showed that officials made a clear contract to purchase materials for a city. Although the material was used for municipal repairs, the higher court refused to hold in favor of the seller because the officials were not authorized by valid state laws to make ultra vires contracts of this nature.

Therefore, while a municipality is bound by its contracts legally entered into within the scope of powers granted by the Constitution and state laws, all contracts *not* within this simple rule are void.

Now, since we have illustrated the law involving a most simple ultra vires contract we shall, before reviewing similar void contracts of intermediate importance, discuss a contract held valid although a part of services was performed *before* the city legally adopted a budget approving the expenditure. This point of the

law was discussed in the recent case of State v. City of Mount Vernon, 20 P. (2d) 29.

In this case it was shown that a city entered into a contract with an engineer to make a survey, appraisal, and report of certain real property which the city intended to purchase. It was agreed that the appraisal work should be paid for by the city and that the amount should be $2,000. This contract was entered into before the city had adopted a budget allowing expenditure for this purpose. However, soon afterward the city officials duly considered an approved this expense in accordance with provisions of a state law. After the appraisal work was completed, certain citizens contended that the city was not obligated to pay for the appraisal work because a part of the services had been rendered before the city had legally approved this work in its budget. However, the higher court held the city liable for payment, and said:

"He did a part of the work before the budget was officially completed, but it is clear that at the date of the adoption of the budget he had not completely earned any part of the total compensation he was to receive, nor did he so earn any of it until he fully completed the survey and appraisal. . . ."

Implied Contract

Although private firms, corporations and individuals may be liable on an implied contract, neither a state, county or city can be held liable on such a contract, ordinarily, because the laws do not validate or approve any but express contracts. This phase of the law was discussed in the recent case of Gugenheim v. City of Marion, 46 S. W. (2d) 478.

The facts of this case are that a contractor and certain city officials entered into a verbal agreement by the terms of which it was agreed that the city should pay the contractor for specified services.

Later the contractor filed suit against the city to recover payment on the grounds that the city had accepted his services, and it was "implied" from the verbal agreement that he should receive payment for his work. However, the higher court held the contractor not entitled to a recovery, and said:

"It is now settled in this state that no recovery against a municipal corporation can be allowed upon an implied contract. . . . The contract was invalid, because it was not not made in the manner provided by the charter of the city. . . ."

Also, see the leading case of Missouri v. Christain, 180 S. W. (2d) 737. In this case it was shown that a state law provides that valid sale contracts made with counties must be authorized by a majority of the judges of the county court.

A seller had his contract signed by a county employe whom the presiding judge had authorized to make the purchases for the county.

The higher court refused to hold the seller entitled to recover payment for the equipment purchased and used by the county.

Law of Lowest Bidder

According to a recent higher court all contracts are void which tend to restrain the natural competition of contractors who bid on public contracts. The courts require contracts to be let by public authorities to the lowest *responsible* bidders and in all instances protect the public against collusive contracts and favoritism. Therefore, any agreement between contractors and subcontractors for the purpose of preventing free and fair competition at public lettings of contracts, or for the purpose of giving undue advantage to any party, is prohibited by public policy and is void. The test of legality is the "evil tendency" of the agreement, and not its actual result in the particular instance.

For illustration, in Finley v. Standard Co., 139 So. 795, it was shown that a contractor submitted a low bid and completed his contract. He was compelled to sue the city to recover the contract price. During the trial evidence was introduced showing that competitive contractors had prevented and interfered with the public officials letting the contract to the lowest bidder.

Therefore, the court held the contractor who had performed the work not entitled to recover the full contract price, saying:

". . . Laws requiring contracts to be let by public authorities to the lowest responsible bidders serve the object of protecting the public against collusive contracts and prevent favoritism toward contractors by public officials. . . . Therefore, any agreement which is made between contractors and subcontractors, or others, for the purpose of preventing free and fair competition at public lettings of contracts, or for the purpose of giving undue advantage to either of the parties, in the performance of public contracts, is void though no actual injury may have resulted."

For comparison see George A. Fuller Co., v. Elderkin, 154 Atl. 548. The testimony showed that a city advertised for bids for installation of a new heating system. The lowest bid was $2,044,000 with no guarantee as to saving of coal. The next bid was $2,046,000 by a contractor who guaranteed a saving of 25% of steam by use of a controlling device. The officials awarded the contract to the lowest bidder but citizens filed suit and testified that the cost of steam with the controlling device would be $3,250 per year less than the system to be installed by the lowest bidder which meant that the lowest bid was actually the high bid. In other words, it was contended that because of the lowest bidder's failure to guarantee any saving in steam consumption, he was not the lowest bidder on the contract. In holding this argument not convincing, the court said:

"Did the failure of the Fuller company to guarantee a saving of steam in its bid make it impossible for the board, in the exercise of a reasonable discretion, to find that said company was the lowest bidder? . . . There is no question here of fraud or abuse of discretion. On the contrary, it was conceded that the members of the board 'canvassed the situation and they came to a conclusion which, in their judgment, whether legal or illegal, was for the best interests of the city'."

Obviously, no official or commission may legally refuse to let a contract to the lowest bidder without definite proof that such contractor is not responsible. This law is applicable, of course, to individuals and private

corporations as well as United States Government, states, counties and municipalities.

Although valid laws specify that municipal contracts must be let to the lowest bidder, the courts hold that the lowest "responsible" bidder is the contractor who shall be awarded the contract. In other words, it is for the discretion of reasonably prudent municipal officials to decide who shall receive the contract, taking into consideration the financial responsibility, integrity, efficiency, industry, experience, promptness, and ability of bidders to successfully carry out the terms of the contract. See 155 Atl. 116; 51 Atl. 737.

But, as explained, public officials cannot refuse to award a contract to the lowest bidder whose reputation and efficiency is dependable.

In Kratz v. Allentown, 155 Atl. 116, a state law was litigated which provides that municipal contracts must be let to the lowest "responsible" bidder.

City officials let a contract to a contractor whose bid was considerably higher than a low bid submitted by another contractor. The officials contended that the lowest bidder was not responsible and could not accumulate enough equipment to meet the requirements of the contract. However, they had no proof to verify this assertion. Therefore, the higher court held the officials bound to let the contract to the lowest bidder, and said:

"It must be kept in mind that municipal authorities are acting for the public, and what they might do as private individuals will not necessarily be sanctioned in the expenditure of public moneys. . . ."

Contracts Against Public Policy

Frequently contracts are held void and against public policy, particularly if the testimony shows that either party was unduly influenced.

For example, in Philpot v. Taylor, 16 S. W. (2d) 4, a contractor named McNulty submitted the lowest bid on construction of a public works. Later it was discovered that the engineer of the district was the contractor's partner in another business. In view of this business connection, the court held the contract void, saying:

"The transaction was contrary to public policy, and void throughout. . . ."

Withdrawal of Bid

Contrary to the opinion of a majority, either a heating engineer or contractor may without any liability withdraw his bid before it has been acted on by the one to whom it was submitted. This law is applicable to all bids submitted to private property owners, and governmental agencies.

See Tobey v. Southern Const. Co., 149 S. E. 914, where county commissioners advertised for bids and a contractor submitted a bid, with the required certified check to guarantee performance of the contract. Before the commissioners awarded the contract the contractor notified the commissioners that he withdrew his bid, and demanded return of the certified check.

The commissioners refused to withdraw the bid because it was the lowest one. In subsequent litigation the higher court held that since the contractor's offer or bid had *not* been legally accepted before the contractor withdrew his bid no contract was made and, therefore, the commissioners must return the certified check. This court said:

"The bid of the construction company was an offer to contract, not binding upon it until legally accepted. . . . In order to make a contract the offer must be accepted unequivocally and unconditionally. . . ."

Air Conditioned Railroad Coaches

Boston & Maine Railroad announced recently that the first of its postwar stainless steel air-conditioned coaches have been added to its rolling stock. There are many innovations in these cars. While of standard size, they seat only 56 persons whereas most air conditioned cars seat 84. Each car has a separate new type of automatic air conditioning unit installed by Frigidaire. At each end of the train, a series of thermometers shows temperatures of the journal boxes. Each car has a glassed-in smoking lounge and 6-ft windows.

In the air conditioning system ducts run along the ceiling and outlet is through a perforated grille alongside the central fluorescent light. Each specially designed, adjustable seat cost $250 before installation; each window cost $50. Storage batteries of the alkaline type, under each car, cost $3200 each.

Special design of seats is based on studies by Professor Ernest Hooten, Harvard anthropologist, of over a thousand contours selected at random in North Station.

Interior of B&M new stainless steel coach. Conditioned air discharges at each side of fluorescent ceiling light.

(Above left) Hotpoint has developed a water heater which draws heat from surrounding air by means of a heat pump. Pictured at left is refrigerant evaporator with simple hood to prevent direct recirculation of cooled air. Dials show Freon pressures, and lab assistant is reading water temperature recorder. At her left is hot water tank. While tests are going on, plans for manufacture are indefinite.

(Above right) Executive board and committee chairmen (1947-48), National District Heating Association. Seated left to right around table: D. W. Loucks, Pittsburgh, 2nd vice-president; Walter Wisschusen, New York, chairman meters and accessories committee; J. A. Barnard, Philadelphia, director; J. J. Collins, New York, chairman distribution committee: E. T. Smith, Detroit, chairman operating statistics committee; G. H. Tuttle, Detroit, 3rd vice-president; R. D. Martin, New York, president; J. F. Collins, Jr., Pittsburgh, secretary-treasurer; Walter Schulmeister, N. Tonowanda, director; H. L. Martin, Boston, 1st vice-president; C. W. Deeg, Philadelphia, chairman sales development committee; and A. R. Mumford, New York, chairman research committee; E. T. Smith, Detroit, chairman operating statistics com- M. A. Hanna, Cleveland, director; J. E. Seiter, Baltimore, chairman educational committee; T. P. Brown, Jr., New York, director; L. S. Phillips, New York, chairman membership committee, and A. F. Metzger, Pittsburgh, chairman commercial relations.

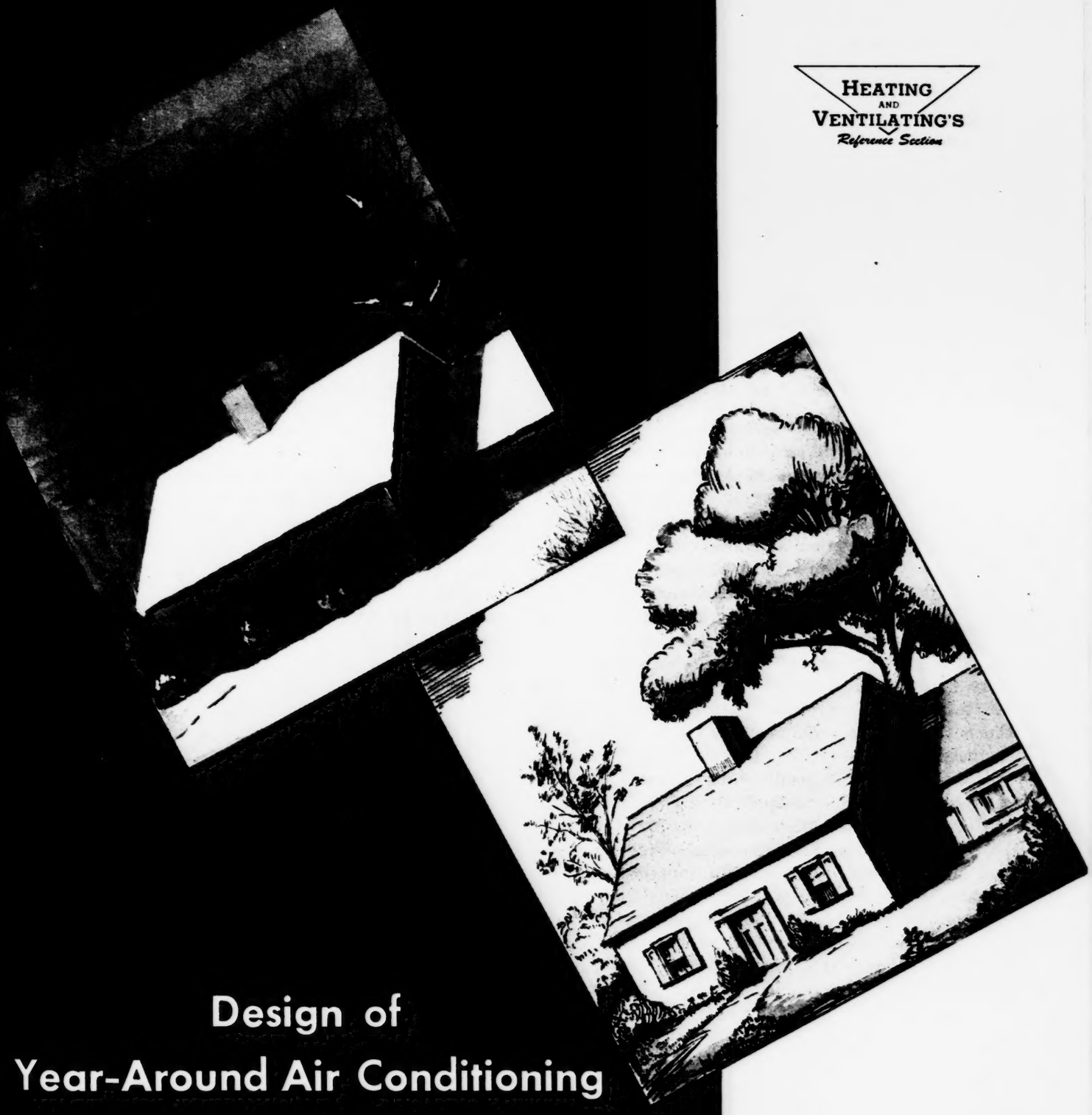
Technique of "roll welding", uses block and fall rigged at each end of a 6-in. pipe line with several turns of chain around the pipe. By unwinding chain, pipe is turned and allows welder to work in downhand position. Photo by Air Reduction Sales Co.

Picture Paragraphs

(Below left) Said to be the world's largest radiant heating installation, a 3-acre pipe warehouse of National Tube Co., U. S. Steel's pipemaking subsidiary in Lorain, Ohio, uses four heat exchangers shown installed on warehouse balcony. Exchangers, connected to plant steam system, heat water circulated in over 25 miles of 1-in. pipe.

(Below right) Effectiveness of an electric fan when used as shown, blowing air out the window from a position three feet from the opening, can be increased 50 to 100% according to tests by Electrical Testing Laboratories sponsored by Westinghouse. Theory is that fan stream entrains and exhausts large volume of room air which is replaced through other room openings from cooler spaces. In-blowing fan would supply only its own stream.

HEATING AND VENTILATING'S
Reference Section



Design of Year-Around Air Conditioning Systems for Residences

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Design of Year-Around Air Conditioning Systems for Residences

L. BERT NYE, Jr.

Superintendent, Technical Bureau, Washington Gas Light Co., Washington, D. C.

Special problems in the design of year-'round air conditioning systems for residences include variation of customer preference, limited space for duct work, need for attractive appearance, etc. Mr. Nye tells how to design around all of these difficulties.

MANUFACTURERS have done much to develop equipment to serve the residential air conditioning market and today several types are commercially available, some manufactured on a production basis. Compression refrigeration and absorbtion refrigeration as well as heat pump systems are being used, and equipment is designed for both electricity and gas fuel. Although the majority of air conditioners sold for residential use in the past have been small room-coolers, it is generally agreed that these were but forerunners of larger units of the central cooling class designed to bring year around comfort to every room in the house and new equipment has been developed along these lines.

The use of central conditioning systems places a real responsibility on the application engineer. The design of an air distribution system to serve a dual purpose, winter heating and summer cooling, presents several problems which are more difficult of solution in residential than in other types of application. Space requirements, seasonal balancing, flexibility of operation without sacrifice of simplicity of control become paramount problems. It is the purpose of this paper to discuss methods for their solution.

Comfort Requirements

Experience has shown the purchaser of residential air conditioning to be an exacting client. Unlike the commercial customer he cannot look on the cost of the system, which is usually appreciable, as a business investment to be recovered out of increased profits, but must justify his expenditure through increased comfort to himself and the members of his household. He expects comfort in accordance with *his* definition of the word, he expects the system to be silent and he does not provide an operating engineer or have much time or money set aside for service calls.

As to temperatures and humidities desired, there is appreciable variance. Demands for cooling have yet to reach the degree of normalcy evident in demands for heating. Operating hours of identical cooling systems in identical houses have shown a difference of over 100% resulting from differences in the amount of cooling desired.

This in itself presents a problem. In general it can be said that the temperatures desired will be lower, seldom exceeding 72F effective temperature, than that desired for commercial applications because the time of occupancy is longer. In many cases residential occupants will not find it necessary to go outside at all on a hot day, as almost all commercial customers must, and thereby lose all touch with outside conditions. We have known semi-invalids who spent the majority of the summer indoors and insisted that they were uncomfortable if the inside temperature ever rose above 75F D.B. A clear initial understanding with the customer as to the conditions to be maintained can prevent later disappointment.

One other important characteristic of the residential customer is that, occupying an establishment of eight or more rooms, he uses them all, moving from one to another, and is quick to notice any temperature difference between rooms.

Equipment Selection

The general public acceptance of air conditioning in residences will require the use of unitary or "package" equipment. The individual engineering, selection, and installation of equipment components, compressor, coils, fan, etc., for each job cannot be justified from a cost standpoint for any but the larger or unusual residential jobs. Fortunately the great majority of residences for which air conditioning is desirable and economically possible are sufficiently similar in size and sensible and latent load characteristics that completely satisfactory air conditioning can be achieved with a choice of a few sizes of unitary equipment.

The labor of designing and selecting equipment for processing the air to be distributed is therefore greatly reduced. Determination of required heating capacity can follow generally accepted methods for the calculation of residence heating loads and the selection of forced warm air heating equipment.

The calculation of required cooling capacities can be simplified somewhat from commercial practice. There is some doubt as to the necessity of calculating the latent load for the average dwelling. Present methods and data for calculation of latent heat loads yield only approximate estimates at best. On the other-hand, the latent load in a typical residence will not exceed 20% of the total and presently available equipment will more than meet this load. Quite satisfactory comfort conditions will be obtained by simple control of the operation by a room thermostat.

Table 1 – Heat Gain from Outside Air

Btu of sensible heat per cubic foot of air infiltrated or provided by positive ventilation.

A. M.		P. M.	
Time	Factor	Time	Factor
1	.11	1	.32
2	.10	2	.33
3	.09	3	.33
4	.08	4	.33
5	.07	5	.33
6	.09	6	.30
7	.12	7	.27
8	.16	8	.23
9	.20	9	.18
10	.24	10	14
11	.27	11	.12
12	.30	12	.11

As a room thermostat is sensitive to sensible heat changes only, it seems logical to select cooling equipment for this application by simply comparing its sensible heat removal capacity with the calculated sensible heat load. Judgment and experience must be used to spot any occasional job where, due to extreme shading, high internal moisture release or other reasons, the percentage latent load is unusually high. Where high latent loads are encountered they can be met by providing added cooling capacity and the use of controlled reheat. Although there may be some extremely damp localities where the "exceptional case" predominates, we believe that this method of selection can be followed with confidence throughout the greater part of the country.

Calculation of Sensible Cooling Loads

Thoroughly satisfactory procedures and data for the calculation of sensible cooling loads are now set forth in published reference works where the tables and charts given are fairly comprehensive, although each engineer may wish to prepare a few of his own to simplify routine calculations. A few are presented with this article.

The outstanding difference between summer cooling and winter heating loads from the standpoint of calculation methods is the importance of the variation of cooling load components with time due to change in sun position, lag in heat transmission caused by heat capacity of the structure and changes in outside temperature. It is necessary to study the hourly variations of the majority sources of heat gain for each job, determine the time at which the sum of these components will be at a maximum and calculate and summarize all heat gain components *at the peak hour of their sum* to obtain a satisfactory accurate load.

The sources of heat gain which must be considered are: heat transmitted through each wall and the roof by air temperature difference and sun radiation, heat transmitted through windows in each wall, heat transmitted through exposed floors, heat required to cool infiltrated air, and internal heat loads, people, lights, and heat or power actuated appliances.

Data presented in standard reference works showing hourly heat gains through roofs and walls of various constructions and orientations are invaluable. These data take into account changes in sun position and lag in heat transfer and cover a wide range of constructions. Heat gain values for other constructions can be obtained by interpolation between the figures given.

Heat gains through glass may be calculated easily from available data using the correction factors given for haze and shading. As the average residence window is covered with a half-drawn buff shade or venetian blind, the designer will find it helpful to prepare a table giving the net gain through glass at various orientations for his locality using the shading factor applicable for these appurtenances.

Factors for heat gains through exposed floors can be calculated or read directly from the chart given in Fig. 1. Heat gains through floors on ground or over basements can be assumed to be zero.

In summer, as in winter, the air that enters an average residence through crack leakage is more than enough to supply all ventilation required for the occupants therein. For example, the normal infiltration into a weatherstripped six-room house is in the neighborhood of 200 cfm which, allowing 15 cfm each, will provide adequate ventilation for thirteen persons. It is, therefore, unnecessary to supply outside air through the air conditioning system and the infiltration heat gain can be based on the amount of air leakage as figured from published data. One must be careful, however, to remember that this load is also periodic, varying with the outside temperature and should be calculated for the peak hour previously determined. Table 1 gives the hourly heat gain per cubic foot of air infiltrated for each hour of the day; calculated for a design temperature difference which ranges from 4F at 5:00 A.M. to 19F at 3:00 P.M.

The sensible heat gain from occupants is usually small and can be taken as 225 Btu per hr per person for the expected occupancy during the peak hour.

The lighting load in residences is also small and can be assumed to be zero unless the peak hour should happen to occur after sundown.

The heat gain from appliances can usually be neglected unless the air conditioning equipment itself

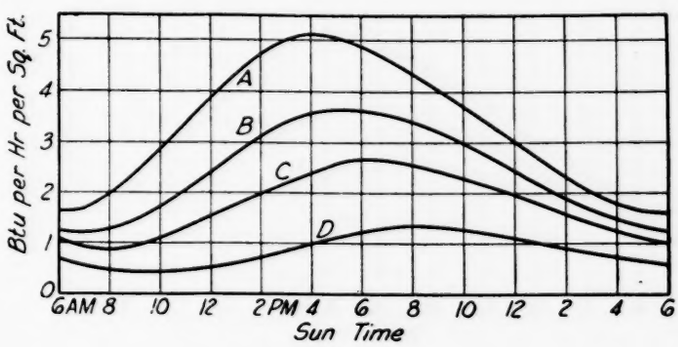

Fig. 1. Hourly heat gain through exposed floors.

A—Double floor, open joists.
B—Double floor, joists covered with sheet rock.
C—Double floor, joists covered with ½-in. insulation.
D—4 in. mineral wool in joist spaces.

happens to be in the conditioned space in which case manufacturers' data as to the heat given off can be used.

Kitchen appliances do give off appreciable quantities of heat. In fact, the total maximum heat input to all kitchen appliances can easily exceed the entire cooling load for the remainder of the house. It is, therefore, common practice to exclude the kitchen, when appliances are in use, from guarantees of cooling system performance.

However, kitchen comfort should not be neglected, but to the contrary, given special attention. The maximum reduction in kitchen temperatures per dollar spent, can be obtained through the use of a properly engineered kitchen ventilating system designed to catch waste appliance heat at its source. Tests by the American Gas Association Testing Laboratories for example, show that a properly designed range hood will easily remove over 50% of the heat given off in normal cooking operations. Besides reducing the cooling load such ventilating systems help control cooking and grease vapors, a true air conditioning function.

Determination of Required Equipment Size

Required heating capacity of equipment should be determined by established procedures.

The cooling capacity of a central unit should equal the calculated building load (adjusted for thermal capacity effects if necessary) plus duct losses.

Duct losses for a residence of average size with air conditioner installed in the basement can be estimated as

All supply ducts bare.....10%
All supply ducts insulated, 1 in..... 5%
(Credit should not be given for insulation on ducts run in exposed spaces such as garages.)

The calculated maximum hourly cooling load can be often modified in determining the equipment capacity required because of the effect of the thermal storage capacity of the building and its furnishings. If the calculated peak load is severe and of short duration, and the building is of heavy construction the added load of the peak will not immediately evidence itself in a rise in house temperature but will be for the most part absorbed by the building mass. This results in a smoothing out of peak loads and allows a reduction in required equipment size.

Allowances by experienced designers for the effect of thermal storage range from 0 to 25% of the calculated maximum load and vary with type of construction, geographical location, duration of peak load, and its severity in relation to the average load and the hours of use. Correlated test data on the effects of these factors are meager and individual experience has been the usual guide. However, a series of field tests projected by the American Gas Association for this coming summer may provide a more exact means of evaluating the effect of various factors involved.

Design of Air Distribution System

It is the purpose of the distribution system to apportion and deliver air, the heat carrying and absorbing medium, from the central air conditioning apparatus to the various rooms and spaces to be heated or cooled. If the system fails to deliver to each room the amount of air which is required to meet the heating and cooling loads of that room, unsatisfactory room temperatures will result. An air conditioning installation can then be no better than its air distribution system. This system stands between the heating and cooling equipment and the living spaces which it serves, and the performance of the installation will be judged by the degree to which perfect temperature distribution is attained.

Air duct systems are closely allied with the building structure and, once the installation is complete, alteration becomes difficult and expensive.

For these reasons, particular care and detail in the design of air distribution systems is well warranted. The following method attempts to recognize all known important factors in design and though it may appear detailed, it has been simplified as far as can be justified by field experience.

The basic steps are:

1—Location of supply and return grilles and diffusers
2—Determination of air quantities to be distributed
3—Selection of supply and return grilles and diffusers
4—Design of duct system.

Location of Grilles

Residential construction limitations will dictate the use of side wall grilles in most cases, although ceiling outlets can be occasionally used and in special cases, vertical discharge from window sills can be used.

As a preliminary step, supply and outlet for all rooms to be conditioned should be located on a scale plan of the residence.

Sidewall supply grille locations should be chosen in accordance with the following:

(a) Grilles should be placed to throw air to, or along the source of greatest heat load.

(b) Grilles should be spaced and adjusted to distribute air over the entire room area.

(c) For cooling service, grilles must be located at least 6½ ft above the floor.

(d) An occasional exception to (c) may be made in rooms with a low cooling air delivery requirement per cubic foot volume such as some first floor rooms in residences. In such cases, a baseboard location may be used if: (1) a register with adjustable horizontal back blades is installed so that air can be directed upward along the wall during the summer and (2) the register can be so located that it is not likely to blow on seated persons.

(e) In spaces with beamed ceilings, high outlets should be located below the lowest beam level and preferably blow along the length of the beams.

(f) Except in relatively warm sections (winter outside design temperature 20F or above), rooms on ground or over unheated spaces, basements, garages, and the like, should have grilles located in the baseboard for heating service.

(g) Exception to (f) may be made, and high grille locations used, in rooms where occupants are standing most of the time such as kitchens.

(h) Locations should be avoided in which grilles are likely to be obstructed by massive furniture, drapes, or open doors.

(i) The physical appearance of outlets should conform to the aesthetic requirements of the room. Unsightly locations should be avoided.

Manufacturers' recommendations can be followed in locating ceiling outlets.

Return grilles should be placed in all conditioned rooms excepting kitchens and baths and should be located in or near outside walls preferably beneath windows to catch cold down drafts.

The choice of grille locations will be restricted by construction details and requirements of space for connecting ducts. In locating grilles and risers in multi-storied buildings with air conditioning unit located in the basement, it is advisable to start locating grilles, both supply and return, on the top floor and proceed downward by floors, spotting all risers on each floor plan.

Determination of Air Quantities

In the design of unitary air conditioning equipment, the manufacturer will establish a design air throughput at which the equipment will give optimum performance. A reduction in air delivery below the manufacturer's specification will usually result in reduced heating and cooling output (because of lowered coil velocities) and is to be avoided unless it is certain that the equipment is appreciably oversize and it is desired to reduce the output to more nearly match the load. When a reduction in output is clearly desirable, manufacturer's ratings for air deliveries at reduced capacities can be followed.

It becomes the problem of the application engineer, therefore, to apportion the total air volume delivered by the air conditioner between the various rooms so as to obtain even temperature distribution summer and winter.

In addition to the calculated heat loss and heat gain of each room to be served, the calculation must take into account the summer temperature gains and winter temperature losses of the air traveling from the conditioner to the rooms to be served. These temperature changes are not uniform, varying with the length, location, and construction of ducts and the quantity of air flowing.

Duct temperature changes will also vary with ambient temperatures which are in turn controlled by duct location, climate, and building construction. Much time can be saved and a sufficient degree of accuracy maintained if use is made of calculated average values for temperature change per linear foot, determined for the conditions commonly encountered in the locality concerned. The following method, which is presented as a guide uses temperature drop corrections developed for systems with conditioning equipment located in basements and installed in the latitude of Washington, D. C.

(1) Locate tentatively all supply and return grilles as discussed in the preceding section, locate air conditioning unit and sketch path of duct system on plan.

(2) Calculate the temperature change in ducts to each supply grille in accordance with the following schedule:

	Winter Drop, Degrees F per Ft	Summer Rise, Degrees F per Ft
Basement ducts, bare.....	.25	.08
Basement ducts, insulated (1 in. thick)	.09	.03
Risers	.5	.16

Temperature drop in insulated ducts run in exposed spaces should be taken same as that in bare ducts in basement.

(3) Determine correction factor to allow for duct losses to each room from Table 2 and calculate the total heating and cooling loads for each room

Table 2 — Correction Factors to Allow for Temperature Change in Ducts

Total Temperature Change, F	Correction Factor	
	Winter	Summer
1	1.02	1.06
1.5	1.01	1.09
2	1.04	1.13
2.5	1.05	1.16
3	1.06	1.20
3.5	1.07	1.24
4	1.09	1.29
4.5	1.10	1.33
5.5	1.11	1.38
5.5		1.44
6	1.14	1.50
6.5		1.57
7	1.16	1.64
7.5		1.71
8	1.19	1.80
8.5		1.89
9	1.22	2.00
9.5		2.12
10	1.25	2.25
11	1.28	Insulate
12	1.32	Insulate
13	1.25	Insulate
14	1.39	Insulate
15	1.43	Insulate
16	1.47	Insulate
17	1.51	Insulate
18	1.56	Insulate
19	1.61	Insulate
20	1.67	Insulate
21	1.72	Insulate
22	1.78	Insulate
23	1.85	Insulate
24	1.92	Insulate
25	2.00	Insulate

Table 3 — Sample Calculation of Heating and Cooling Demand in a 5-Room House

Room	Duct Length, Ft		Temperature Change, F		Correction Factor		Room Heat Load, Btu per Hour		Total Corr. Heat Load		Supply, Cfm		Ratio	Return, Cfm
	Bas.	Ris.	W	S	W	S	W. Loss	S. Gain	W	S	W	S	S/W	S & W
Kitchen.....	12*	2*	4	1.3	1.09	1.08	8,500	2,100	9,260	2,270	119	84	.71	...
*Living Room..	10	8s 2w	3.5	2.1	1.07	1.14	15,000	4,100	16,100	4,670	208	173	.83	197
*Dining Room..	14	8s 2w	4.5	2.4	1.1	1.16	9,000	3,100	9,900	3,600	127	134	1.05	194
N. Bedroom...	10	16	10.5	3.4	1.27	1.24	10,000	4,200	12,700	5,210	165	193	1.17	268
S. Bedroom...	14	16	11.5	3.7	1.3	1.26	12,000	6,300	15,600	7,940	201	294	1.46	341
Bath.....	14	20	13.5	4.3	1.37	1.32	4,500	2,500	6,170	3,300	80	122	1.53	...
Totals							59,000	22,300	69,730	26,990	900	1000	1.11	1000

*These rooms to use alternate high and low registers on common risers for summer and winter service; winter register in baseboard, 2-ft riser, and summer register 7-ft above floor, 8-ft riser.

W = Winter S = Summer

by multiplying the calculated room heat losses and heat gains by these factors. Total these corrected loads.

(4) Determine the heating and cooling air quantities required for each room by dividing the total air quantity to be supplied between rooms in proportion to their respective total heating and cooling loads.

(5) Calculate ratio of summer to winter air requirements for each room. This ratio will aid in analysis of the seasonal balancing problem to be discussed later.

(6) The total calculated return air volume should equal the total volume of air supplied. Although temperature change through the conditioner will make these volumes unequal in actual operation, the direction of their differences will differ, summer and winter and the change need not enter into quantity calculations. Also, as the balancing of the return system does not affect temperature distribution sufficiently to require a seasonal adjustment, it will be sufficiently accurate to apportion the individual room return air quantities on the basis of the summer or winter supply air quantities, whichever has the greater total. Air supplied to rooms without returns should be returned through grilles in adjacent rooms.

A sample calculation is shown in Table 3.

Selection of Grilles

Much excellent information on grille and diffuser performance and selection is given in manufacturers' catalogs. These data are presented in an assortment of forms varying in completeness and simplicity.

To assemble data applicable to residential work in a simple but comprehensive form, two grille selection charts have been prepared, one for high side wall location, Fig. 2, and one for baseboard location, Fig. 3. These charts are limited to standard sizes and velocities used in residences and present all data necessary for the selection of suitable grille sizes and the determination of operating resistances.

To use these charts, first locate the point of intersection of the curve of the required cfm and the curve of the established room width or throw. This point indicates the ideal face area and face velocity; read at the left side and bottom of the chart. Horizontally to the right of this point will be found a choice of grille sizes, their ranges of use indicated by brackets.

After selecting the grille of most suitable dimensions, determine its actual performance by proceeding along the cfm curve from the point of ideal performance to the actual face area line as indicated by the peak of the grille bracket. Proceeding vertically from this new point read the actual face velocity at the bottom of the chart and the total grille resistance at the top.

Return grilles may be selected by use of the chart for baseboard grilles. The room width may be neglected and grilles selected on the basis of desirable pressure drop only.

The chart for selection of high sidewall registers is based on the use of grilles with a vertical bar deflection not exceeding 42°. For the delivery of large volumes with short throw or grilles for very large rooms in which the air quantity or throw is beyond the scope of the chart, reference should be made to manufacturers' catalogs.

In selecting supply registers consideration must be given to both summer and winter performance; maintenance of proper air throw and problems of spring and fall balancing of air distribution. In some instances it may be desirable to provide registers for only heating or only cooling service. In other cases it may be advisable to readjust the calculated air deliveries between adjacent rooms to give better year around register performance. Greater latitude in summer deliveries can be allowed without upsetting temperature distribution.

Design of Duct System

The duct system provides the air path from the conditioner fan outlet to the supply grille and from the return grilles back to the conditioner inlet. To deliver the required air quantities, ducts must be of such size that, for each room, the total resistance of the supply duct and register plus the total resistance of the return duct and grille must be within the available external pressure rating of the conditioner fan.

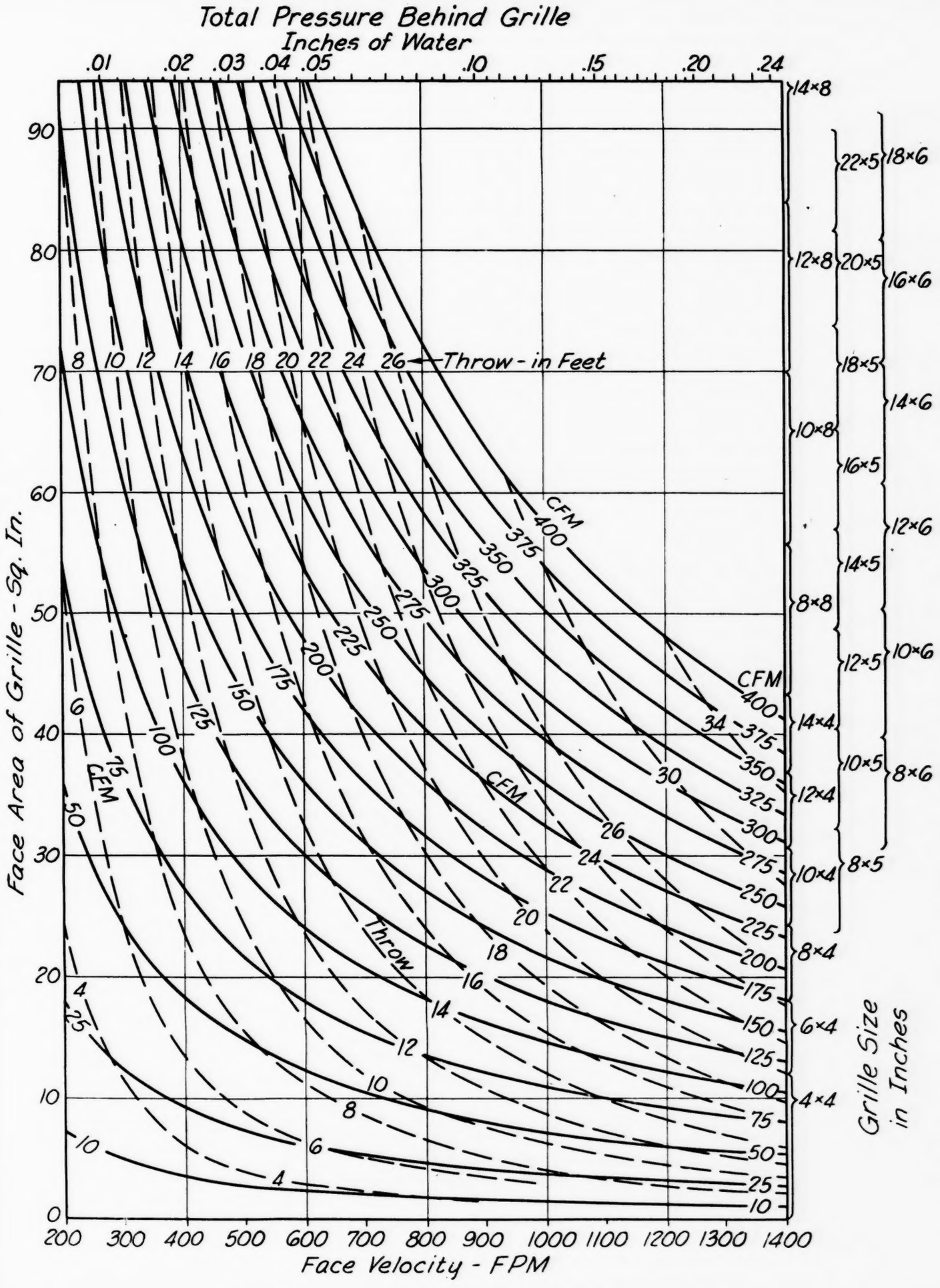

Fig. 2. Grille selection chart for locations 7 to 12 ft above floor.

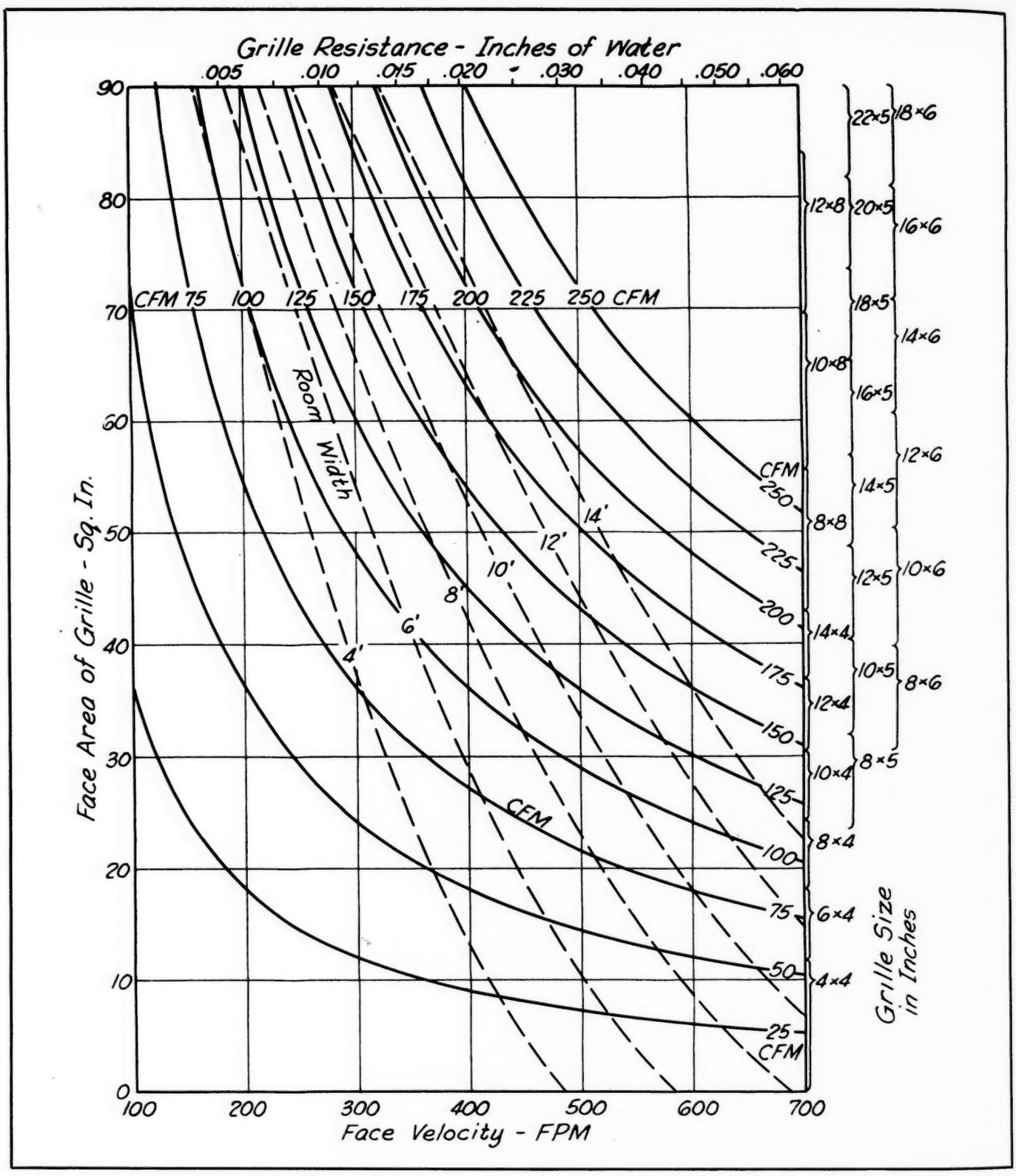

Fig. 3. Grille selection chart for locations in baseboard. For heating service using combination downward and horizontally deflecting grilles only.

The factors governing the flow of air through ducts can be expressed by the formulas,

$$h_1 = 1.1 \frac{L}{CD^{9/7}} \left(\frac{V}{4005} \right)^{13/7} \text{ and } Q = \frac{V D^2}{4}$$

At this point in the development of a system design the factors which have been fixed are: L, the total duct length, including equivalent length of fittings; C, a constant determined by surface friction characteristics of the duct material; and Q, the volume of air to be delivered. The remaining three factors, h_1, the pressure drop; V, the velocity; and D, the diameter, are as yet undetermined interdependent variables related by the formulas.

With three variables and only two equations, it is apparent that more than one solution to the duct de-

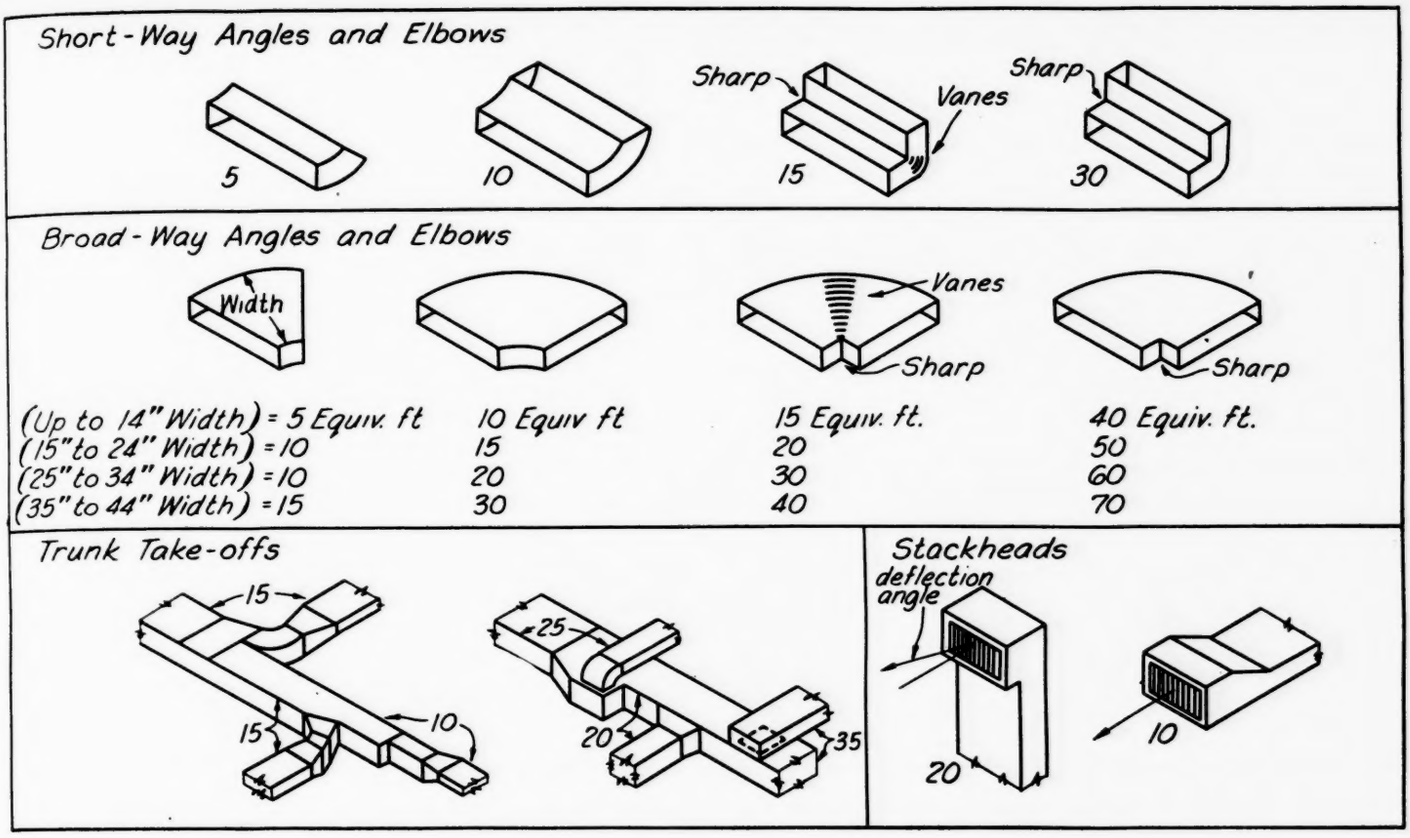

Fig. 4. Equivalent length of fittings. Figures are feet of equivalent length.

sign problem can be obtained. This has led to the development of several "methods" of duct design, foremost being the Equal Friction method, the Static Regain method, and the Velocity Reduction method.

Although the factors h_1, and D have been said to be variable they are only variable between definite limits in most residential installations. As indicated in a foregoing paragraph, the sum of pressure losses, which must be determined separately for each portion of the duct run which varies in size or air quantity carried, must be held within the available pressure at the fan outlet. The duct diameter D (or its equivalent rectangular dimensions) is all too frequently limited by the space available for ducts; in fact, the necessity of adapting duct design to meet space limitations is of prime importance in the selection or development of a duct design method suitable for residential air conditioning use. The limitations of these two factors do not admit insertion into a formula and therefore give rise to "cut and try" procedures.

Each of the aforementioned methods of design necessarily starts with an assumption. The Equal Friction method establishes an equal pressure drop per foot throughout the duct length. It is convenient in that the required drop per foot can be calculated by dividing the available fan pressure by the total length, establishing a starting point for a step by step procedure, but the concept of equal friction loss per foot has no other inherent value.

The Static Regain method was developed for large systems using multiple outlets having similar air distribution requirements, such as high pressure window cabinets used in office buildings. It establishes a uniform static pressure behind all outlets. Although this method is logical for such large systems it has little value in residential system design where, due to variation in room size and air quantities, the static pressure required behind outlets is far from uniform.

The Velocity method allows the designer to establish such velocities as he sees fit, generally increasing from outlet to fan, after which pressure losses determined and velocities readjusted where necessary to obtain the desired pressure drop. It is a strictly empirical method and should be used for only the simplest of design problems.

The duct design procedure here presented might be termed a modified Equal Friction method in which the concept of equal friction per foot throughout the duct length is adjusted where necessary to meet space limitations.

In operation the air distribution will adjust itself so that the total resistance of each supply duct run and register will be equal and the total resistance of each return duct run and grille will be equal. Good design will provide that when this condition is obtained the required air quantities will be delivered with a minimum of duct damper adjustment.

With this thought foremost, duct sizes can be determined as follows:

(1) Sketch path of supply and return duct systems from registers and grilles to conditioning unit and determine as well as possible the types and locations of fittings. In determining general duct scheme, consideration should be given to seasonal balancing problems by study of summer to winter air ratios determined in the air distribution schedule. It may be desirable to connect groups of supply branches having similar summer-winter

ratios to common trunks so that seasonal balancing can be effected by a few trunk dampers.

(2) List the register resistance as determined on the register selection chart.

(3) Select the supply duct run which by reason of its length or high register resistance appears to have the greatest total resistance.

(4) Determine the equivalent length of each portion of the duct run which will vary in dimensions or air quantity carried using the chart of Equivalent Lengths of Fittings, Fig. 4.

(5) Determine maximum air quantity to be carried summer or winter in each section of duct listed in (4) above.

(6) Using a duct friction loss chart and a chart of circular equivalents of round ducts select sizes for each portion of the supply duct system so that:
   (a) Ducts can be installed in the space available. Remember that duct cost often can be held down by using stock sizes where possible.
   (b) The total resistance of the duct run from conditioner to and including register will be about half of the available pressure drop. Resistance of supply system can be greater than half of the total if it is possible to design the return system at a sufficiently low pressure drop to keep the total supply and return resistance within the available fan capacity.
   (c) Air velocities increase progressively from the register to the conditioner outlet, if possible, to minimize velocity head loss.

(7) Select duct sizes for other supply runs in a similar manner so that the total resistance of each supply run does not exceed the established resistance of the supply system. Design labor can often be reduced by oversizing short runs, eliminating resistance calculations, where it is obvious that the resistance of the run will be less than that of the rest of the system. In operation the resistance of such runs will be built up by throttling adjusting dampers. However, duct costs will be reduced and the possibility of noise from air turbulance around partially opened dampers eliminated if duct sizes are made no larger than necessary. On the other hand, reduction of duct sizes below 6 in. x 3 in. is seldom warranted because of fabrication difficulties.

(8) Design return system in a similar manner, using a total resistance which when added to the total resistance of the supply system will not exceed the available pressure drop at the fan outlet.

A sample layout for the example in Table 3 is presented in Fig. 5.

Balancing and Adjustment

Mention has been made of the problem of seasonal adjustment or balancing of the air distribution system. Inspection of the comparative summer and winter air supply values of the example in Table 3 shows an appreciable variance for different rooms. It is obvious that for this typical job, some adjustment in air distribution must be made each spring and fall if

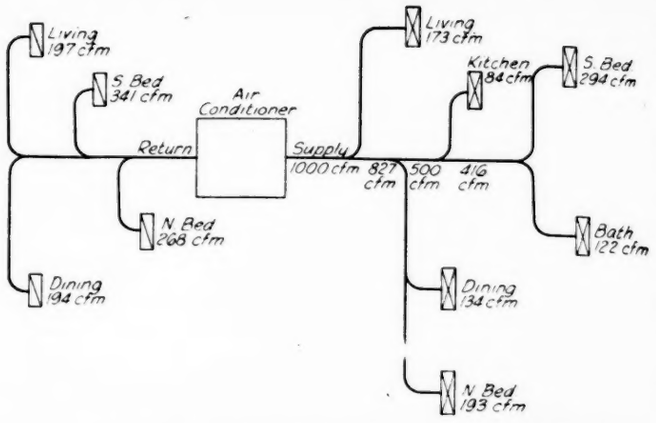

Fig. 5. Duct system for air quantities calculated in Table 3. Designed for .30 in. w.g. total available fan pressure external to air conditioner.

satisfactory temperatures are to be obtained. This can be accomplished through various means. The south bedrooms and bath supply ducts, which each require about 50% more air in summer than winter can be connected to a single trunk, see Fig. 5, fitted with a volume damper for manual adjustment, spring and fall. A separate damper can be installed to throttle the kitchen supply line which requires 29% less air in summer. However, as this room could be served by a high sidewall grille (see notes on grille locations) and as the cooling load was calculated without appliance heat it should be quite satisfactory not to reduce the summer air delivery. The north bedroom supply line may also be equipped with a separate damper. Following the recommendations on grille location, the dining room and living room would each be supplied with combination high sidewall and baseboard registers on common risers. Summer and winter air flow through these registers can be adjusted separately by stackhead dampers when the system is installed so that subsequent seasonal balancing can be accomplished by simply opening the high register and closing the low register in the spring and reversing the process in the fall.

In addition to the summer-winter changeover dampers, the system must be necessarily equipped with balancing dampers to allow final adjustment of air distribution. This is necessary not only to make up for any lack of precision in design calculations, but primarily because, as pointed out before, it is impractical to reduce the size of all of the short duct runs to the point where their resistance will equal the maximum for the system when passing the required air volume. Dampers should be provided in the return as well as the supply system to control cross drafts.

In balancing the system it is helpful to first adjust the air delivery for both summer and winter, by velocity measurement at each grille, to conform to the design values. Performance should then be checked by measuring temperatures of all rooms under load conditions and any necessary final adjustments made to equalize room temperatures. The engineer can then prepare instructions for summer-winter changeover, noting the registers and dampers to be reset, instruct the customer in their use and consider his job complete.

Air Entrainment by Forced Hot Water Flow in Pipes

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This is a report of tests with transparent tubing which indicate that air venting at every high point is not essential when velocities are kept above a certain threshold.

AIR vents at all high points in a system, and eccentric reducers with the straight side up for pipe size reductions are generally standard practice in forced hot water heating.

To investigate the possibilities for more freedom in piping design, a series of tests were performed to determine above what water velocities thorough air bubble entrainment by the water is achieved for various sizes of pipe.

Tests were carried out with Saran tubing for the smaller sizes and Pyrex pipe for the larger sizes tested in order that the passage of air bubbles could be visually followed.

Inside diameters used were:

Saran-In. Dia.	Pyrex-In. Dia.
0.25	0.615
0.41	0.866
0.50	1.22
0.626	1.45

Four-pass coils were formed of the Saran, and two-pass return bends of the Pyrex, both materials bent on about 9-in. centers.

Coils were tested in various positions and observations made to determine velocity of water flow required for air entrainment. A recording was made at slightly above the threshold point, and another reading at clearly above the threshold of entrainment. To compute the velocities, water passing through the tubing was collected for a given time and weighed on a platform scale.

Tests were made with tap water at 64 and 160F, with practically no variation noticed in required flow rate within the range of accuracy of the readings.

Readings on the 0.626 Saran and the 0.615 Pyrex gave almost identical results.

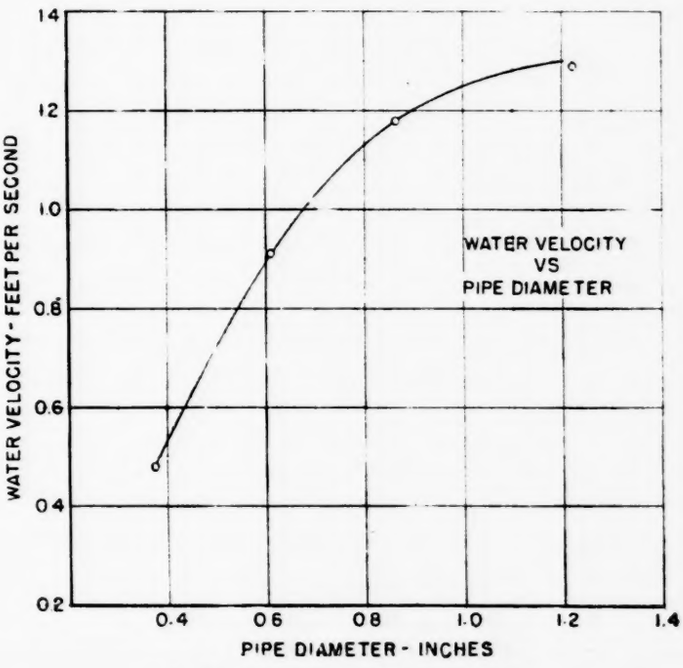
The curve shown is for wall coils with horizontal straight runs connected by return bends, with down flow of water through the coils. This arrangement represented the severest condition found for air entrainment. It was observed that at lower velocities than those recorded, the air bubbles definitely are dragged along the top of the pipe in horizontal runs; however, when an ell or bend downward is reached, the air accumulates into larger bubbles at the bend rather than carrying through with the water, and the circuit could eventually become air locked.

Point of entrainment is taken as the minimum velocity at which the largest air bubbles were cleared through the return bend. The curve is plotted for water flow at or slightly above the threshold point of entrainment.

Readings on the 0.25-in. tubing were not plotted because the test showed air clearance is obtained down to practically zero flow. This condition very likely holds true to nearly ⅜-in. dia tubing.

The curve is plotted only through the 1.22-in. pipe. On the 1.45-in. dia, the point to be plotted is considerably above the trend of the curve. For a 90-degree ell downward on 4½-in. radius, the curve may be extended and holds true. However, in the case of return bends in the larger size pipe, the combination of the centrifuging of the water from the air on the one hand, and the buoyancy of the air bubble on the other, is sufficient to require higher velocity to clear the bubble through the second 90 degrees of the return bend. This effect did not have much influence on readings for pipe tested smaller than 1.45-in. dia.

While it is recognized that, in practice, the occurrence of return bends in the position tested would be most unusual for pipe sizes above ¾-in., this scheme



Air entrainment with water flow.

was used throughout for uniformity. In a later paragraph an approximate percentage factor is given to apply to ordinary ells and a vertical drop.

From the information obtained in the tests, the following conclusions were reached.

Air Vent Location. Air vents are not essential at every high point when velocities are kept above the threshold point. An air vent would be required, however, at a level no farther below the circuit high point than the maximum head the pump can exert across the circuit. Otherwise the buoyancy of the air column could lock the circuit, with the water short circuiting through parallel coils, or the circulator operating at static no delivery.

Circuit Friction. Minimum head loss through each of the parallel coil circuits must be high enough so that air cannot collect and trap one circuit, while the water flow short circuits through the remaining parallel circuits.

Stilling Chambers. Low velocities observed for entrainment lead to the conclusion that for effective air venting at any point in a system, the velocity of flow should be reduced to at least slightly below the threshold point to permit air separation, especially at drops in horizontal runs. Otherwise the air bubbles may be carried past the vent, resulting in a "gurgly" system.

Long Radius Bends. Long radius bends require higher velocities for entrainment of air than required for vertical flow in straight pipes. The velocity required in the vertical drops is roughly 75% of velocities required for the return bends, as spot checked with the ¾ and 1¼-in. pipe. Although no tests were run on standard ells, it appeared that in comparison with the 4½-in. radius tested, the sharper the turn, the lower the velocity required for clearance down to the 75% point mentioned.

Eccentric Reducers. Flow through a 1.22 × 0.5-in. concentric reducer drawn in the Pyrex pipe revealed that air entrainment by the water is obtained at all but the very lowest velocities—below threshold in the reduced size pipe and that evidently under most ordinary circumstances, eccentric reducers serve no useful purpose in forced flow work.

Tests reported were carried out primarily for practical purposes. The authors recognize there is considerable room for additional investigation of more exact nature and broader scope.

The work was performed in the chemical engineering laboratory of the University of Washington with the co-operation of A. A. Peterson and R. G. Newbury.

Allowable Atmospheric Concentrations of Contaminants

The maximum allowable concentrations of atmospheric contaminants followed as industrial hygiene standards in Kentucky, are presented in the following tabulation released by the State Department of Health.

Industrial Hygiene Standards

Contaminant	Parts per Million	Milligrams per Cu M
Acetone	200	
Acrolein	1	
Ammonia	100	
Amyl acetate	400	
Amyl alcohol	55	
Aniline	5	
Arsenic trioxide		0.5
Arsine	1	
Benzine (naptha gasoline)	1000	
Benzene (benzol)	75	
Bromine	1	
Butanol	100	
Butyl acetate	400	
Cadmium		0.1
Carbon dioxide	5500	
Carbon disulphide	20	
Carbon monoxide	100	
Carbon tetrachloride	50	
Chlorinated napthalenes		1 to 5
Tri		5.0
Above Tri		1.0
Penta		0.5
Chlorine	1	
Chlorobenzene	75	
Chloroform	100	
Chromium compounds		0.1
Dichlorbenzene	75	
Dichlorethylene	100	
Dichlorethyl ether	15	
D.N.T. (dinitro toluene)		1.5
Ethyl alcohol (ethanol)	250	
Ethyl chloride	2000	
Ethlene dichloride	100	
Ethyl ether	400	
Formaldehyde	20	
Gasoline	1000	
Hydrogen chloride	10	
Hydrogen cyanide	20	
Hydrogen fluoride	3	
Hydrogen sulfide	20	
Iodine	0.5	
Iron oxide fume (F_2O_3)		15
Lead		0.15
Magnesium		15
Manganese		5
Mercury		0.1
Methyl alcohol (methanol)	100	
Methyl bromide	50	
Methyl chloride	500	
Naptha	5000	
Nitrobenzene	1	
Nitrogen oxides (nitric acid)	10	
Ozone	1	
Petroleum vapors	1000	
Phosgene	1	
Phosphine	2	
Phosphorus trichloride	0.7	
Sulfur dioxide	10	
Sulfur trioxide (or sulfuric acid)	2	
Tetrachorethane	10	
Tetrachlorethylene	200	
Toluene	200	
Toluidine (O-M-P)	2.5	
Trichlorethylene	200	
Tetryl		1.5
T.N.T. (trinitrotoluene)		1.5
Turpentine	200	
Xylene	200	
Zinc oxides		15
Silica	5 million free silica particles per cu ft	
Asbestos	5 million particles per cu ft	

Ventilation of Long Tunnels During Construction

W. B. HARRIS

Engineer, New York State Department of Labor, Division of Industrial Hygiene

In this second part of his three-part article, Mr. Harris discusses the types of equipment suitable for use in tunnel ventilation and gives some means of predicting performance.

PRIMARY air-moving equipment for this type of operation may be any available high pressure, high volume blower. The most practical type found was the positive pressure blower. This equipment had the advantage of delivering the required air quantity against the constantly increasing pressure encountered as the tunnel became longer. In addition to this the flow of air could easily be reversed, merely by reversing the motor of the blower. The main disadvantage of this equipment was its excessive noise. Some suppression of this noise was possible through the use of silencers, but this was not wholly successful. The noise in the tunnel was like rapid-fire pistol shots on each air pulse. This condition seemed to decrease somewhat with increased pipe length.

A high vacuum turbine fan such as that shown in Fig. 4, was used successfully, having much quieter underground operation. It was noted, however, that where resonant lengths of pipe was used, a loud, high-pitched whine was present in the tunnel, but this effect was not as objectionable as the intense noise of the type previously described. Main disadvantages of this class of blower were the adjustments necessary. A valving system was needed for reversing the direction of air flow. Two connections were made, each to the intake and the discharge. One of each of these led to the outside, and to the tunnel. Proper valving in these pipes enabled the direction of flow to be reversed without stopping the operation of the fan. This equipment took considerable space and required much more time and attendance than the mere throwing of a switch as in the case of the positive pressure equipment.

Because the cfm characteristic of this type blower deviates more markedly from a straight line than does positive pressure equipment, it needs continual speeding-up to maintain a reasonably constant air flow. In practice the fans were over-speeded and dampered by means of a crank-actuated iris orifice valve. When the valve was completely opened and the output fell below that required, the pulley sheaves were changed and the speed was increased to the next working level.

Piping

The only piping suitable for this operation was found to be heavy gauge steel piping. No substitute would stand the treatment and pressures without excessive losses. There was practically no choice between types of or makes of piping. Spiral-weld and seam-weld were used with equally good success. Joining the piping, however, was a considerable problem. A dependable, tight joint was necessary to prevent leakage of a major portion of the air delivered by the fan. Four types of joint were used: Flanged ends, rubber gasketed and bolted; U-section bolted ring; sleeve fit with a rubber ring gasket; and welded. Of these, the tightest joint was possible with the U-section ring. It was the easiest to assemble, having only one bolt. The next most efficient joint was the bolted flanged joint. Surprisingly enough, the welded joint showed the worst performance, probably due to the difficulty of welding a clean joint in the position necessary in placing the pipe. With the piping tied directly to the tunnel wall, it was extremely difficult for a welder to work on the inside of the peripheral seam.

Beside steel piping, in some cases use was made of flexible duct, Fig. 5. The collapsible type was used, for example, where rock formation was such as to be blasted back to the pipe end. Blasting under such conditions was known to destroy piping at as great a distance as 125 ft from the working face, although this was unusual. In this case the piping was carried to within 150 ft of the face and a flexible duct brought it to

Fig. 4. High vacuum turbine fan used to produce quieter underground operation than the positive pressure blower.

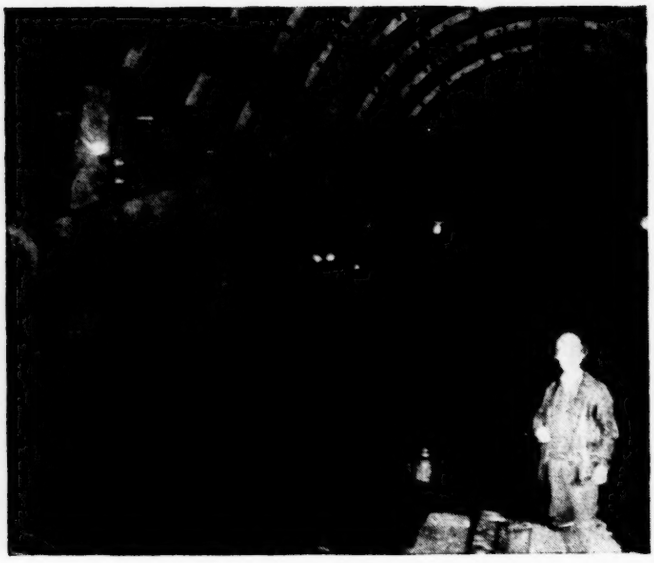


Fig. 5. Collapsible type ventilation piping used where blasting of rock formation could injure rigid piping.

within 50 ft of the face during the blow cycle. One attempt was made to use non-collapsible duct for the entire cycle, which made it possible to carry air directly to the heading. The duct end was wired to the side wall to prevent its whipping or pulling back during suction. Its use was discontinued after it broke loose from its anchorage during an exhaust period, collapsed, and closed the end of the main line. Approximately 500 ft of 24-in. diameter $\frac{1}{8}$-in. steel piping was collapsed before the relief valve on the positive pressure blower could operate.

Where impregnated cloth piping was used for long runs, leakage through the cloth—tears, joint, and the porous cloth itself, made its use prohibitive beyond a relatively short distance.

Other Equipment

In only one case was use made of a booster fan in the line. The bore had progressed beyond the ability of the primary blower to deliver the required air quantity. Rather than change the main blower, an effort was made to increase the volume by placing a booster in the line. The remedy proved almost completely ineffective and it was necessary to install more powerful equipment.

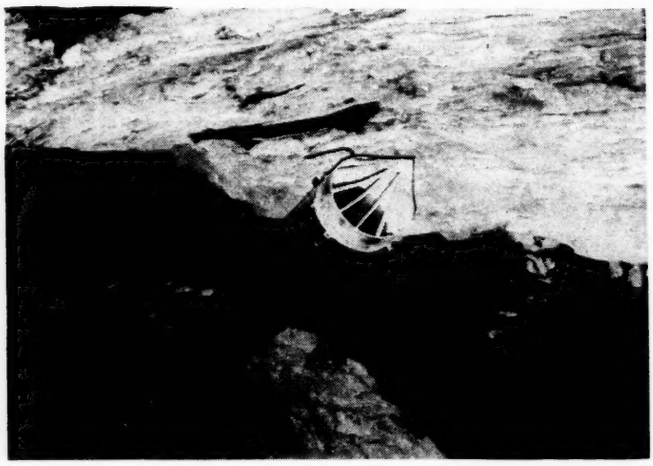


Fig. 6. Finger type casting for protecting end of main supply duct from flying rock.

In order to minimize damage to the end of the vent pipe caused by stray flying rock, a conical shaped welded steel grille was successfully employed, Fig. 6. The apex was formed by 12¾-in. by 2-in. bars bonded together. These bars spread toward the base where they were welded on to a steel ring bolted to the end of the pipe. The apex pointed toward the blast and formed an effective deflector.

It might be worthwhile at this point to describe a piece of auxiliary equipment which was not strictly a part of the ventilation system but was used to assist one of the main functions of ventilation. This equipment was a simple, high pressure spray nozzle made from an 18-in. length of 3-in. pipe. It was squeezed almost closed at one end to form a flat narrow slot. Into the body of the pipe was welded a one inch piece of water pipe. After the heading was prepared for blasting this nozzle was placed on the end of the air line and connected to a one inch water line. The water was opened full, and the air supply opened to form a high pressure spray shooting toward the face. This spray was allowed to operate from the time the men were withdrawn from the face to allow for blasting, until the first man returned to the heading after blasting. It was possible with this device to reduce from 40 minutes to 20 minutes the time lapse before men could return to work after blasting. Dust concentrations were rapidly reduced and, in some inexplainable manner, so were the concentrations of toxic gases. Use of this spray caused an initial saturation of the muck pile which reduced the dust concentration during the mucking operations to a lower level than would be possible without its use.

Diesel Engines

Use of diesel locomotives underground is already widespread and will continue to increase. These units can be operated safely if adequate precautions are introduced. It was our experience that two 100-ton diesel locomotives could safely be used in a tunnel in which the ventilation rate was at least 14,000 cfm. This was, and of course would be, contingent on many factors relating to the engine and to the operating conditions. A simple measurement was evolved which will show the adequacy of the ventilation rate. It was determined that when a concentration of less than 20 parts per million of CO was found in the air downstream of the engine, no complaints were raised by the workers. At any figure above this, complaints became considerable—even to the point of operators laying down tools and refusing to work.

Method of Prediction – Miscellaneous

To predetermine the horsepower requirements for ventilation equipment, it is necessary to predict the order of magnitude of the several variables. In the case of equipment used in underground ventilation, the essential factors are:

1. Total eventual length of piping
2. Resistance per foot of piping at various velocities

3. Percent of air leakage per foot of piping
4. Terminal air quantity requirements
5. Factors determining pipe diameter
   a. Available space within shaft or tunnel
   b. Availability of materials
   c. Economic balance: Fan motor cost v. piping and erection cost.

Terminal length of piping usually is accurately predictable, but in the case of tunneling, it can be seriously modified during construction. For example, in one tunneling operation which was observed, two shafts were sunk about 28,000 ft apart. These were expected to meet about midway, so the ventilating systems were based on 15,000 ft of length. At about 7,000 ft from one shaft, some almost impassable ground was encountered, and the progress from that end came essentially to a halt. That left some 20,000 ft to be carried by the system from the other shaft, and an extra mile of piping with its added leakage and resistances meant an additional 50 hp.

Terminal air quantity can be predicted quite accurately if the physical specifications of the operation are known or can be estimated.

Table 1—Resistance for 26 and 28 In. Diameter Pipe

Derivation	Reference	Resistance—Inches per 100 Feet	
		26-In. Dia 2600 FPM	28-In. Dia 2400 FPM
Measured		0.28	0.23
Chart No. 2	1	0.50	0.40
$h = 0.65 \frac{Q^2}{D^5}$	1	0.50	0.39
$h = \frac{L}{57D^{1.25}} \left(\frac{V}{4005}\right)^{1.85}$	2	0.17	0.12
Chart No. 5	1	0.36	0.28
$h = 27.5 \times 14.7^2 + \frac{Q^2}{20d^5}$	1	0.36	0.27
$h = \frac{L}{CD} \left(\frac{V}{4005}\right)^2$	3		
C = 50*		0.39	0.31
C = 70		0.28	0.22
$h = C \frac{V^2}{d} (0.0009 + \frac{0.036}{(Vd)\ (0.35 \times 10^{-6})}$	4		
C = 6.0*		0.25	0.20
C = 6.5		0.27	0.22
C = 7.0		0.29	0.23
$h = 1.1 \frac{L}{CD^{5.1}} \left(\frac{V}{4005}\right)^{\frac{13}{7}}$	5		
C = 50*		0.364	0.285
C = 70		0.28	0.22
$h = \frac{C}{D^{1.212}} \left(\frac{V}{4000}\right)^{1.83}$	6		
C = 1.157		0.21	0.17
C = 1.48		0.26	0.22
Table 2		0.29	0.24

Where h = resistance, inches per 100 ft; Q = total quantity of air, cubic feet; L = pipe length, 100 ft; D = pipe diameter, feet; d = pipe diameter, inches; V = air velocity, feet per minute; C = constant

*Recommended constant

REFERENCES

1. P. H. and F. M. Roots Co., engineering tables, Bulletin No. 1181
2. Fundamentals Relating to Design and Operation of Exhaust Systems. American Standards Association—Z-9
3. Heating Ventilating and Air Conditioning Guide
4. Determination and Control of Industrial Dust, U.S.P.H.S. Bulletin No. 217
5. Nomograph for duct sizing, HEATING AND VENTILATING, November, 1946, page 89
6. Heating Ventilating and Air Conditioning Guide

The remaining factors, those requiring specific engineering information, are resistance and leakage.

Prediction of Resistance

Resistance in an air duct is usually computed or estimated from one of the theoretical fluid friction equations or a curve of some type derived either from

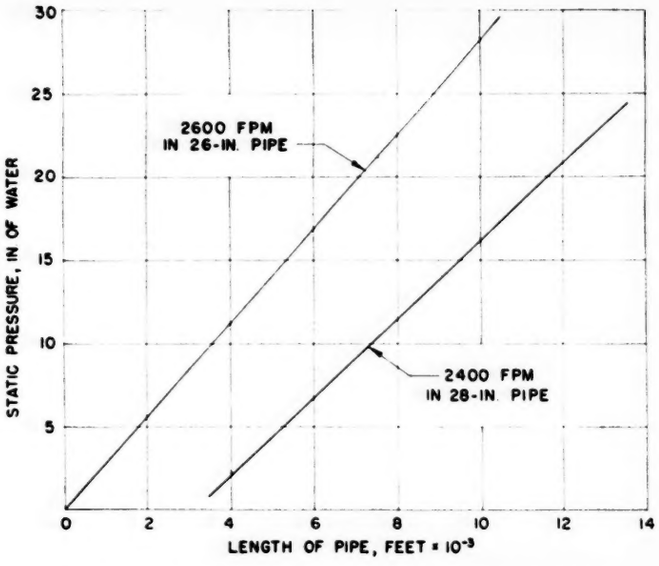


Fig. 7. Plot of resistance measurements in 26-in. and 28-in. pipe.

such an equation or from some type of empirical data. The resistance figure from these sources is expressed in inches of water per hundred feet of piping if the pipe diameter and air velocity are known.

From measurements taken every 1,000 ft in 26-in. and 28-in. diameter piping, curves have been plotted from which it is possible to obtain resistance figures for two given sets of conditions of pipe size and velocity, Fig. 7. These figures are compared with other figures representing computations based on the same conditions. Table 1 shows a comparison of these figures. From these values, it can be seen that the more complex and supposedly more fundamental equations do not necessarily present a more accurate picture of resistance. Table 2 shows the figures which have been used as a basis for resistance calculations by New York State Department of Labor, Division of Industrial Hygiene for many years. These data are a composite of those from many sources tempered by considerable experience and have been found to afford

Table 2 — Resistance Data Used by the New York State Department of Labor

D Duct Size, In.	D^2 Sq. In.	Duct Area		Factor, Ft. to Equiv. Dia.	Equiv. Dia. for		Dia. per VP	
		Sq. In.	Sq. Ft.		90 Deg. Ell	45 Deg. Ell	2000-3000 FPM	3000-4500 FPM
2	4	3.142	0.0218	6	9	5	40	45
2½	6¼	4.909	0.0341	4.8	9	5	40	45
3	9	7.069	0.0491	4	10	5	40	45
3½	12¼	9.621	0.0668	3.43	10	5	45	45
4	16	12.57	0.0872	3	10	5	45	45
4½	20¼	15.90	0.1104	2.67	10	5	45	45
5	25	19.64	0.1364	2.40	10	5	45	50
5½	30¼	23.76	0.1650	2.18	11	6	45	50
6	36	28.27	0.1964	2	11	6	50	50
6½	42¼	33.18	0.2304	1.85	11	6	50	50
7	49	38.49	0.2673	1.71	11	6	50	50
7½	56¼	44.18	0.3068	1.6	11	6	50	55
8	64	50.27	0.3491	1.5	12	6	50	55
8½	72¼	56.75	0.3942	1.41	12	6	50	55
9	81	63.62	0.4418	1.33	12	6	55	55
9½	90¼	70.88	0.4923	1.27	12	6	55	55
10	100	78.54	0.5454	1.2	12	6	55	55
11	121	95.03	0.6600	1.09	12	6	55	55
12	144	113.1	0.7854	1	12	6	55	60
13	169	132.7	0.9218	0.924	13	7	55	60
14	196	153.9	1.069	0.857	13	7	55	60
15	225	176.7	1.227	0.800	13	7	55	60
16	256	201.1	1.396	0.750	13	7	60	60
17	289	227.0	1.576	0.706	13	7	60	60
18	324	254.5	1.767	0.667	13	7	60	65
19	361	283.5	1.969	0.632	14	7	60	65
20	400	314.2	2.182	0.600	14	7	60	65
21	441	346.4	2.405	0.572	14	7	60	65
22	484	380.1	2.640	0.546	14	7	60	65
23	529	415.5	2.885	0.522	14	7	60	65
24	576	452.4	3.142	0.50	14	7	60	65
25	625	490.9	3.409	0.48	14	7	60	65
26	676	530.9	3.687	0.462	14	7	65	65
27	729	572.6	3.976	0.444	14	7	65	65
28	784	615.8	4.276	0.429	14	7	65	70
29	841	660.5	4.587	0.414	15	8	65	70
30	900	706.9	4.909	0.400	15	8	65	70
31	961	754.8	5.241	0.387	15	8	65	70
32	1024	804.3	5.585	0.375	15	8	65	70
33	1089	855.3	5.940	0.364	15	8	65	70
34	1156	907.9	6.305	0.353	15	8	65	70
35	1225	962.1	6.681	0.343	15	8	65	70
36	1296	1018	7.069	0.333	15	8	70	70

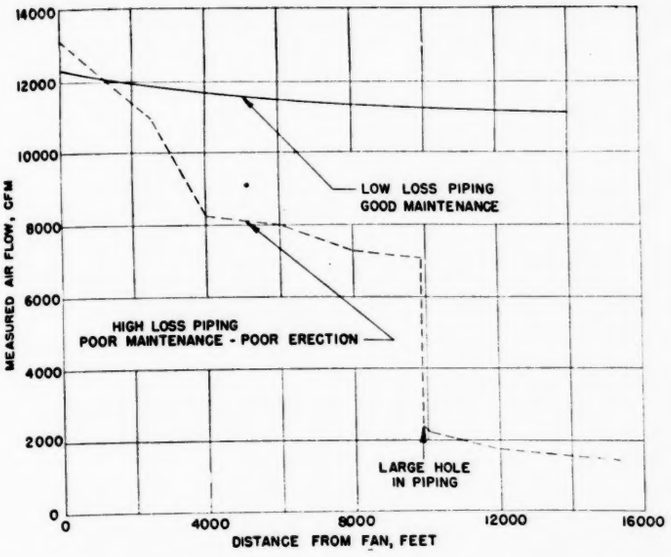


Fig. 8. Loss characteristics of two similar piping systems.

a reasonably accurate means of computation. It should be noted that the derivation of this table was completely independent of the figures found in this study.

Although no extensive claims can be made on the basis of the limited number of variables which have been checked, the successful use of Table 2 for the smaller pipe sizes in a large number of applications plus the reasonably accurate check at this larger size would point to its accuracy being at least as good or quite possibly better than that of the more complex methods of computation.

As noted previously, the leakage factor is one which is too variable to be predicted accurately. It depends largely on the type of pipe construction and the care of erection. It can be kept to a minimum by the use of efficient pipe coupling. Measurements of leakage, Fig. 8, that were taken at various locations showed leakage figures which varied from a maximum of something more than 20% for every 1,000 ft of pipe, or a total of almost one cfm per ft of pipe length, to a minimum of about 15% for 10,000 ft of pipe.

Whereas it is conceivable that this latter figure could be improved upon, it is not expected that any great improvement would be found under normal construction conditions with reasonable maintenance. If it is desired to maintain adequate conditions of ventilation throughout a construction project of considerable magnitude, it is strongly recommended that at least 0.2 cfm per ft of pipe length be added to the ventilation design rate for leakage. After installation, readings of air flow should be made at each end of the pipe at frequent intervals to check effectiveness of maintenance and resultant air leakage. If the design factor of leakage is reached in the early stage of construction, it will mean trouble ahead unless more rigid maintenance is kept. If the loss should suddenly increase, it will probably mean a major leak, which should be located immediately. This may best be done by taking air flow readings at periodic distance intervals by means of a direct reading velocity meter inside the pipe.

Next month, Mr. Harris will discuss control of dust, gases, etc.

Volcanic Ash Makes Building Material

Volcanic ash, a substance hitherto considered worthless, that lies in deposits of millions of cubic feet in 27 counties of Oklahoma and other states of the Southwest is likely to have an important place in building and various phases of manufacturing in the near future according to A. L. Burwell, chemical engineer for the Oklahoma Geological Survey of the University of Oklahoma.

He has developed a method by which the volcanic ash, a gray powder, can be made into industrial, building and insulating material. The product, as he has developed it after two years of experiment, has been named "Pumicell" and it is fireproof, sound-absorbent, moisture, rot and vermin resistant. It can be processed and sawed like wood, and is so light that it will float on water. With its insulating qualities, Mr. Burwell says, it will make a practical wallboard for refrigerators, cold-storage lockers and all types of fireproof buildings.

The geological chemist found, when he was analyzing various "useless" Oklahoma minerals, that when volcanic ash is heated in an oven it "bloats" or forms natural gas cells which make it light and easy to mold. Different temperatures in the oven give the product different characteristics, and it can be made solid or porous as desired.

Tests showed that after heating to 1,090 C the ash shrinks and becomes a brick red. At 1,200 C it turns gray and expands some. Further heat expands it still more as the natural gas cells begin to form. Mr. Burwell explains that the insulating properties of Pumicell exists because of the bubbles which form throughout the material during the heating process. Remaining in the substance when it cools and hardens, they also give the substance high sound-proofing quality.

Various tests made show that the raw product can be made into bricks, slabs or strips, and it varies in weight from 18 to 56 lb per cu ft. It can be made in any desirable strength up to 4,200 lb per sq in. It holds paint so tenaciously that enamel cannot be scraped from its surface and any color can be baked on to its surface during the heating process.

NEWS OF EQUIPMENT AND MATERIALS

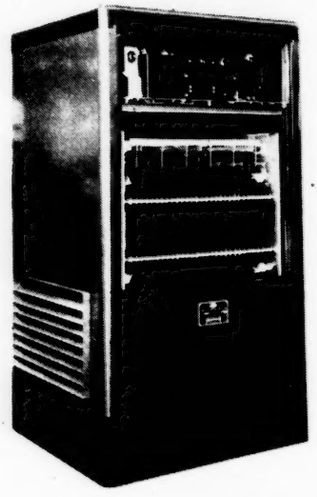
Inert-Arc Welder

NAME—Type WP inert-arc welder.
PURPOSE—A-c welding transformer designed specifically for use with the inert-arc welding process.
FEATURES—Built into a single unit arc welding transformer, control panel, capacitors for power factor correction, a bank of series capacitors to stabilize the arc, a pilot spark circuit for arc starting, and water and gas solenoid valves. Welding current is controlled by turning a handle on top of the welder. An indicator scale on the front shows the current setting. The control panel is connected so

as to permit the independent operation of the gas and water valves. After initial adjustments are made on the panel, operations are by means of foot treadle.
MADE BY — *General Electric Co., Schenectady, N. Y.*.....**488**

Home Air Filter

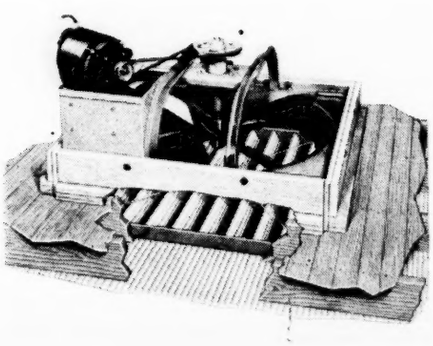
NAME—Raytheon home precipitator.
PURPOSE—Filtering air in an entire house by electrostatic means.
FEATURES—Unit is designed to operate in conjunction with and part of the air conditioning or warm air system of house. It is attached to air intake of furnace or air conditioning unit. Device consists of power pack and an ionizer-collector



cell. Power pack utilizes regular house current to energize the ionizer to create a strong electrostatic field. As air-borne particles pass through the electrostatic field, they become positively charged and are attracted to dust collector plates. Collector plates are washed periodically by a water spray to remove the dirt. Power consumption is 50 watts per hour.
SIZES AND CAPACITIES—Cabinet is 54 in. high, 28 in. wide, 27 in. deep and the unit weighs 300 lb. Rating is 1,200 cfm.
LITERATURE AVAILABLE—Illustrated folder.
MADE BY — *Raytheon Manufacturing Co., Waltham, Mass.* **489**

Ventilating Fan

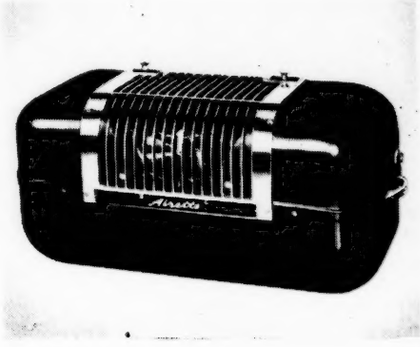
NAME — Silent Breeze H. M. ventilating fan package.
PURPOSE — Attic fan design for homes with limited attic space.



FEATURES — Package includes a Silent Breeze ventilating fan, suction chamber, automatic ceiling shutter, and electric motor. Fan is designed to operate at peak efficiency in the horizontal position and can be installed in a home having 2 ft or more clearance between attic floor and roof. Entire unit, less time switch and ceiling shutter, is assembled at the factory. Installation requires cutting and framing a suitable opening in the attic floor, placing the shutter and fan, and the necessary wiring.
MADE BY—*Holcomb & Hoke Mfg. Co., Inc., Indianapolis, Ind.* **490**

Air Conditioner

NAME—Airette air conditioner.
PURPOSE—Self-contained portable room cooler.
FEATURES—Portable unit which requires no plumbing connections, has a 3 gal water reservoir. When knob is turned to cold position, a centrifugal pump powered by a 1/40 hp motor forces water through



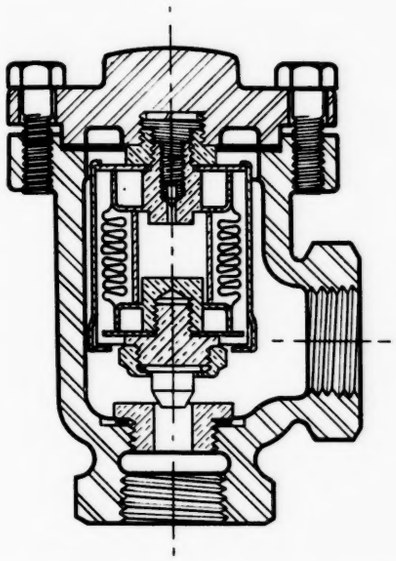
a manifold which distributes the water over an air filter. Fan draws air through moist filter pad and drives the air through the forward grille, thereby achieving cooling through evaporation. When control is set for heating, a nichrome electric heating element generates the necessary heat. Humidity is controlled by a valve at the end of the cabinet.
MADE BY—*Airette Manufacturing, Inc., 1041 N. Sycamore Ave., Los Angeles 38, Calif.* **491**

Thermostatic Trap

NAME — Sarco cast steel thermostatic trap.

PURPOSE—For trapping steam condensate in installations where trap will be subjected to shock.

FEATURES—Cast steel body and cap provide strength necessary for unit to withstand shocks resulting from external explosions as in chemical plants. Stainless steel thermostatic element is said to handle corrosive condensate effectively and is designed for a maximum operating pressure of 300 lb per sq in. Another model of this series has a



bronze thermostatic element for use up to 225 lb per sq in. saturated steam. Thermostatic element is a patented helical bellows which provides a greater air venting capacity. When installed to discharge to the atmosphere, no protection is required against freezing.

LITERATURE AVAILABLE — Bulletin P. R. 1176.

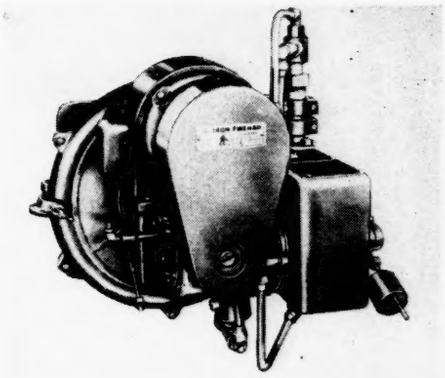
MADE BY—*Sarco Co., Inc., 475 5th Ave., New York 17, N. Y.* **492**

Industrial Oil Burner

NAME—Iron Fireman type R industrial oil burner.

PURPOSE—Burner for firing No. 6 oil or lighter for industrial applications.

FEATURES—Burner is of the horizontal, rotary atomizing type in which oil is metered into a horizontal cup rotated at high speed. Makers claim extremely accurate control of the oil feed rate. Low speed gear type pump maintains supply of oil in the reservoir to provide a head of oil at all times over the metering pump. Metering pump is submerged in oil reservoir to serve the rotary atomizing cup. Multiple cylinders maintain an even flow. Shape of flame may be adjusted to fit proportions of combustion chamber. Control combinations can be provided to meet specific requirements. Models available for manual, semi-automatic or full automatic operation.



LITERATURE AVAILABLE—Illustrated folder.

SIZES AND CAPACITIES—Burners have capacities from 8 to 125 gal per hour.

MADE BY—*Iron Fireman Mfg. Co., Cleveland 11, Ohio.* **493**

Radiant Heating Valve

NAME—Radiantrol.

PURPOSE — Balancing and air vent valve for use with radiant heating systems.

FEATURES — Valve is similar to a butterfly type control valve and can be used with pipe coils buried as deep as 8 in. below the concrete surface. The hollow brass control stem can be cut to appropriate size and extends from a brass floor plate 3⅝ in. in diameter. The traffic plate sets flush with the concrete floor and can be operated by foot. Valve disc is built into a wrought iron body. Venting is accomplished by removing the brass floor plate and the hollow stem and turning a small cap screw on top of the valve bonnet to permit escape of air from the piping system.

SIZES AND CAPACITIES—In sizes adjustable to both 1 and 1¼ in. pipe.

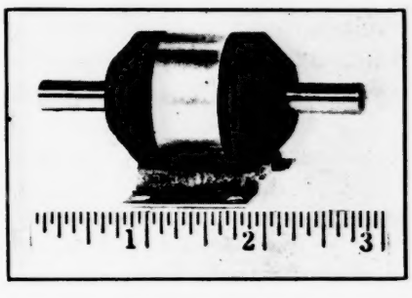
MADE BY—*Homestead Valve Manufacturing Company, Inc., Caraopolis, Pa.* **494**

Speed Changer

NAME—Metron small speed changer

PURPOSE — For use with controls and instruments.

FEATURES—Available in gear ratios



of 15, 10, 9, 8, 7, 6, 5, 4, 3, 2 and smaller. Power may be transmitted in either direction. Spur gear construction is used and all gears are hardened. Drive shafts are mounted in permanently lubricated ball bearings. With some applications, speeds as high as 20,000 rpm and torques as large as 2 lb are permissible.

SIZES AND CAPACITIES—Unit has an overall length of 2-11/16 in. and a body diameter of 1-1/16 in.

MADE BY—*Metron Instrument Co., 432 Lincoln St., Denver 9, Col.*...**495**

Oil Conversion Burner

NAME—Winkler oil conversion burner.

PURPOSE — For converting home heating plants to the automatic burning of oil.

FEATURES — Low pressure conversion burner is claimed to burn even the poorest grade oil over wide viscosities. Oil is metered and premixed with low pressure air to secure thorough atomization of the fuel before secondary air is added

to support combustion. The burner is self cleaning. There is only one adjustment—auxiliary air to fan. A newly developed nozzle has a cone with orifices large enough to preclude clogging with dirt.

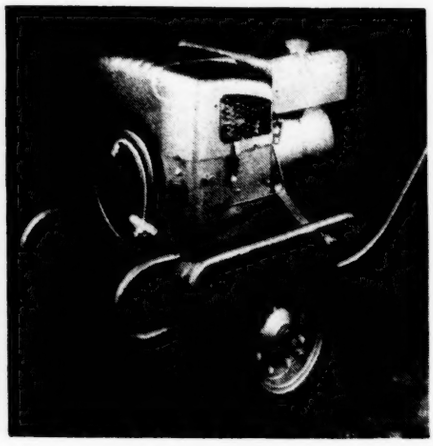
MADE BY — *U. S. Machine Corp., Lebanon, Ind.* **496**

Portable Filter

NAME—Sureweld.

PURPOSE — Portable lightweld gas-driven welding unit.

FEATURES—Light weight is obtained through use of an aluminum housing and aluminum alloys in engine parts where possible. Generator and engine are directly connected. Generator is a four-pole, self excited type with interpoles. Welder is rated at 150 amperes at 30 volts on 50% duty cycle. It has a four-cycle, two cylinder, opposed design motor and an air-cooled turbine type fan for cooling purposes. Two models are available,



one mounted on a two-wheel dolly and the other a stationary type with a guard frame.

LITERATURE AVAILABLE — Descriptive circular.

MADE BY—*National Cylinder Gas Co., 205 W. Wacker Drive, Chicago, Ill.* **497**

Package Boiler

NAME — Wickes package type-A water tube boiler.

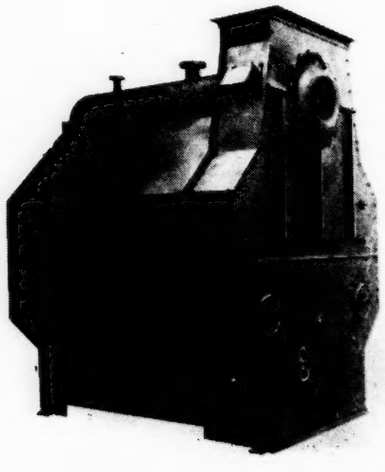
PURPOSE — Steam generation at pressures up to 850 lb per sq in.

FEATURES—Each furnace wall is a separate steam generator, as well as being an integral part of the boiler unit. Upper drum and lower drums are protected from intense furnace heat. Water walls safeguard front and rear refractory walls. Unit is produced as a steel cased package type unit which can be shipped ready for operation with a minimum of installation problems, according to the manufacturers.

SIZES AND CAPACITIES—From 20 to 250 hp.

LITERATURE AVAILABLE — Bulletin No. 46-1.

MADE BY—*The Wickes Boiler Co., Saginaw, Mich.* **498**

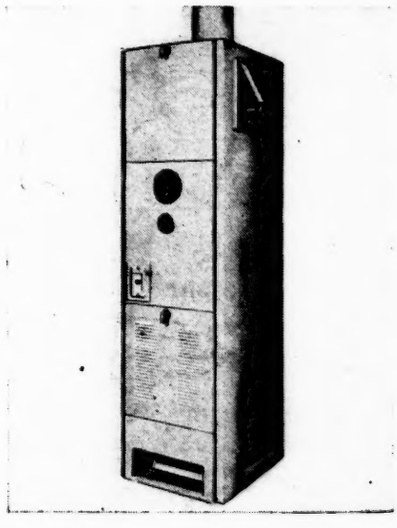


Warm Air Furnace

NAME—International R9 oil-burning furnace.

PURPOSE—Compact, packaged warm air furnace.

FEATURES—Air is forced out at the bottom of the furnace. Return air entering the top of the unit is forced down over the the surface of the cobustion drum by a circulating air blower. An automatic safety switch and cut off are built in and connected to the outlet box of the furnace. All wiring is complete to the electrical parts. Where ducts

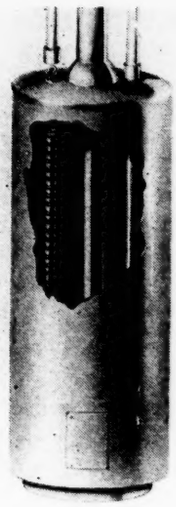


are desired, knock out blanks are provided at the sides, front, back or underneath the furnace. Blower and motor are cradled on spring mountings. A limit control governs the temperature of air within the furnace. Fan is started when the air is heated and stops before cool air can be circulated. Unit occupies little floor space so that it can be installed in an alcove or closet. For basementless homes, insulated ducts are run beneath the floor to the various rooms.

MADE BY—*International Oil Burner Co., St. Louis, Mo.*.....**499**

Electrolysis Control

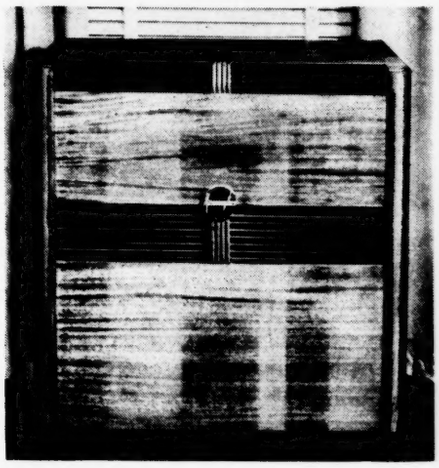
NAME—McRay treater.
PURPOSE—To control electrolysis and prevent the formation of scale in hot water heaters.
FEATURES—A number of zinc and copper plates are mounted in series and then submerged in the water to set up an electromotive force to make inert the salts and minerals



in the water. Device is inserted at the hot water outlet and is suspended in the water. Size for household use has a capacity of 300 gal water per day.
MADE BY—*McRay Sales Co., 1156 E. Colorado Street, Pasadena 1, Calif.* **500**

Air Conditioner

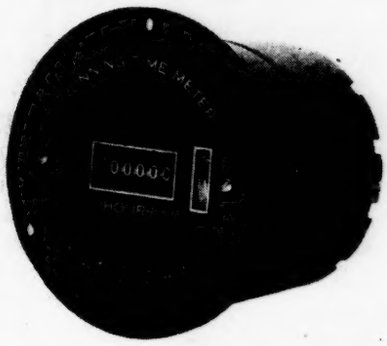
NAME — Remington Model 10 air conditioner.
PURPOSE — Heavy duty air conditioning unit designed for heavy demands of tropical service.
FEATURES — Unit has a combined sensible and latent cooling capacity of 10,500 Btu per hour, conditioned air supply of 400 cfm and an adjustable ventilating air supply up to 75 cfm. Both ventilating and recirculated air are filtered. Conditioned air discharge is variable as to direction and velocity. A multi-cylinder Freon-12 compressor is driven by a 1 hp motor. Centrifugal fans provide air to the condenser and evaporator. Fans are driven by a ¼ hp motor. At present the unit is offered for 50-cycle, 60-cycle or direct current of either 230 or 115 volts.



MADE BY—*Remington Corp., Cortland, N. Y.* **501**

Running Time Meter

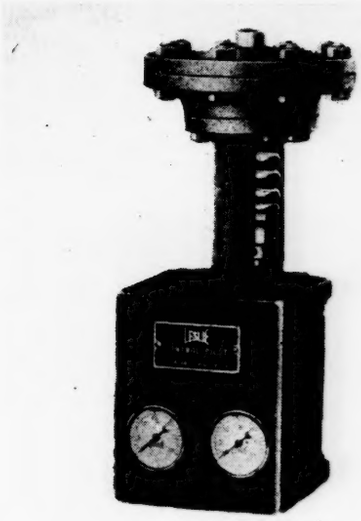
NAME — Cramer running time meter.
PURPOSE — To automatically register the running or idle time of any a-c circuit.



FEATURES — Instrument indicates in 0.1 to 10,000 hours and then repeats. Counter can be reset to zero. The synchronous motor used in these meters is of the slow speed, self-starting type that will start and operate satisfactorily on rated voltage plus 10%. Three types of meter are available and can be furnished for 50- to 60-cycle frequency, and 110 or 220 volts.
MADE BY—*R. W. Cramer Co., Inc., Centerbrook, Conn.* **502**

Pressure Control Pilot

NAME—Leslie pressure control pilot.
PURPOSE—For controlling the action of a diaphragm regulating valve so as to maintain a constant controlled pressure for a standard diaphragm regulating valve.



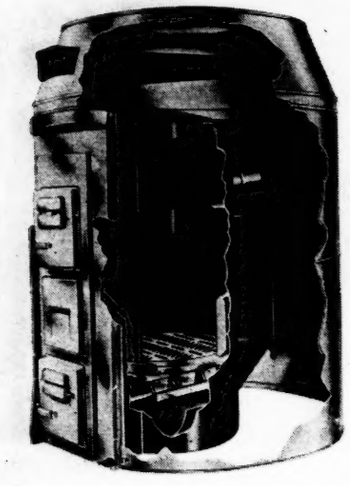
FEATURES—Unit is designed for use with air, clean gas, water or light oil. Mechanical unit is said to be free from recalibration during its service.
SIZES AND CAPACITIES—Nine controlled pressure ranges from ½ to 800 lb per sq in.
MADE BY—*Leslie Co., 52 Delafield Ave., Lyndhurst, N. J.* **503**

Stoker

NAME—Unifeed coal burner.
PURPOSE—Automatic burning of coal in the small home.
FEATURES—Stoker has fan, transmission and motor in one unit, mounted together on a steel plate so that the mechanism can be slid into a steel compartment inside the heating plant. Coal is fed automatically from bin to fire and is controlled by a thermostat setting. Unit includes an automatic air-measuring device.
MADE BY—*Stoker Div., Link-Belt Company, 2410 W. 18th Street, Chicago, Ill.* **504**

Coal Furnace

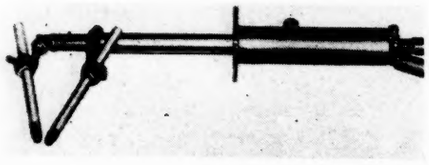
NAME — Norge-Heat coal burning furnace.
PURPOSE — For heating 5- to 10-room houses.
FEATURES—Furnaces are designed for ready conversion to oil or adaption to stoker feed operation. In assembling, the furnace casing sheets are hooked to the front moulding and tightened with a draw band to eliminate the need for nuts and bolts. Furnace body is of heavy steel boiler plate with



electrically welded seams. Grate is of the heavy duty locomotive type. Furnace is equipped with a chain regulator and check damper, and a porcelain lined humidifier.
SIZES AND CAPACITIES — Available in 22, 24 and 27 in. inside body diameter, with bonnet outputs that range from 108,000 to 154,200 Btu per hour.
MADE BY — *Norge-Heat Division, Borg-Warner Corporation, Detroit, Mich.* **505**

Arc Torch

NAME—Phillips arc torch.
PURPOSE—For welding and brazing operations for which a soft flame is the most suitable source of heat.
FEATURES—Current is conducted by two concentric metal tubes, one sliding within the other and insulated by a fiber sleeve. A control



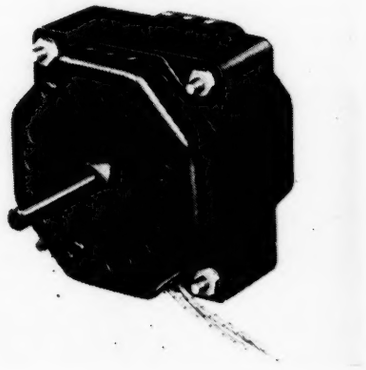
button is located in the fiber handle so that it is directly below the thumb when the torch is held in the hand. Makers say that torch can be used with all types of arc welding machines. Unit is furnished with both bayonet and lug type terminal connectors. Holder will take carbon electrodes from ¼ to ⅜ in. without the use of adapters.
MADE BY—*C. E. Phillips & Co., 2750 Poplar Street, Detroit 8, Mich.* **506**

Motor Repair Kit

NAME—Wagner motor repair kit.
PURPOSE — For stocking replacement parts of Wagner motors to facilitate repair work.
FEATURES—Two size kits are available. M-1 contains a variety of 61 replacement parts most commonly needed in repairing appliance type motors up to and including ½ hp size. M-2 contains an assortment of almost 700 replacement parts for repulsion start induction and capacitor-start motors up to and including 3 hp. Each kit has a list of contents printed on the inside cover to facilitate reordering.
LITERATURE AVAILABLE — Bulletin MU-34B.
MADE BY—*Wagner Electric Corp., 6400 Plymouth Ave., St. Louis 14, Mo.* **507**

Small Motor

NAME—Alliance model B small motor.
PURPOSE — Fractional horsepower motor for driving fan blades, circulators etc.
FEATURES—Motor is semi-enclosed four-pole shaded induction motor that measures 3¼ in. over the bearing housing. Starting torque is approximately 40% of the torque at the full load rating. Model illustrated is rated at 1/70 hp at 1600 rpm. Larger or smaller horsepower



ratings may be obtained by varying the lamination stack thickness.
MADE BY—*Alliance Mfg. Co., Cleveland, Ohio.* **508**

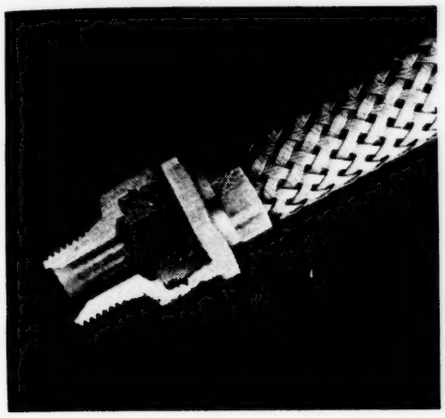
Heater and Air Circulator

NAME—Howard combination heater and air circulator.
PURPOSE—Heating and ventilating.
FEATURES—Unit is light in weight and portable. Speed of fan is reduced when the heating element is

energized. Horizontally mounted radial wire coils comprise the heating element, and the horizontally mounted fan directly above this element distributes the heat. Unit is powered by an E-M-C No. 800 fractional horsepower motor that is built into the air circulator.
MADE BY—*Howard Industries, Inc., 231 S. La Salle St., Chicago 4, Ill. Sales representative: The Herbert Company, 188 West Randolph St., Chicago 1, Ill.* **509**

Metal Hose

NAME—Uniflex flexible metal hose.
PURPOSE—For general use requiring flexible hose connections.
FEATURES—Tube is formed into a uniform helically corrugated flex-



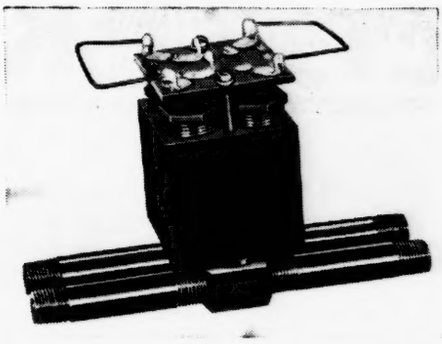
ible hose. Hose is encased in a high tensile bronze wire braid sheath. Specially designed couplings provide metal to metal seat. No packing is required.
MADE BY — *The Brockway Co., Naugatuck, Conn.* **510**

Metal Finish

NAME—P-5 coating.
PURPOSE — Anti-corrosive coating for metal, wood, and concrete.
FEATURES—Paint is said to be free from objectionable odors and dries by evaporation without requiring an oxidation period. Paint film is said to be highly resistant to abrasion and scrubbing and to have good aging characteristics. It is available in nine colors.
MADE BY—*The Watson-Standard Co., Pittsburgh 12, Pa.*.....**511**

Thermal Conductivity

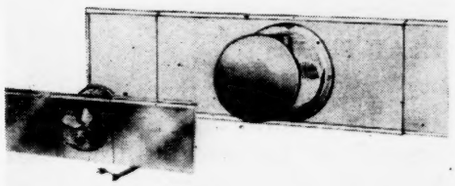
NAME—Gow-Mac thermal conductivity unit.
PURPOSE—To provide a simplified means for studying gases by the thermal conductivity method.
FEATURES—Four filaments are assembled in chambers and wired to form a balanced bridge arrange-



ment. When used with a suitable source of constant voltage, the degree of unbalance of the bridge circuit provides a measure of the relative thermal conductivity of an unknown gas or the quantitative variation in a known gas. Makers claim unit is relatively unaffected by vibration or ambient and current change. All parts are precision machined and there is no glass or cement to crack. Each cell is tested to 10 lb per sq in.
MADE BY — *Gow-Mac Instrument Co., 22 Lawrence St., Newark 5, N. J.* **512**

Air Circulator

NAME—Cir-Q-Laire.
PURPOSE—For exhausting air from a room for use as an air circulator.
FEATURES—Placed in a window, unit functions as an exhaust fan. Turned around and placed at any point in a room, it can serve as a cooling fan. Unit is light in weight



and is powered by a fractional horsepower motor.
MADE BY—*Cir-Q-Laire Co., 60 E. 42nd St., New York 17, N. Y.*.....**513**

Reflective Coating

NAME—Gilsonite reflective roof coating.
PURPOSE—Roof paint to deflect sun's rays.
FEATURES — Makers claim tests show paint can deflect 70% of sun's rays. One gallon covers 300 to 400 sq ft and can be applied with either paint brush or spray gun.
LITERATURE AVAILABLE — Booklet and heat test reports.
MADE BY—*United Gilsonite Laboratories, Scranton 1, Pa.*.....**514**

AUGUST, 1947

TO OBTAIN FURTHER INFORMATION ON NEW EQUIPMENT

On the list below, circle the item number of the equipment in which you are interested, using the number found at the end of each item.

488	489	490	491	492	493	494
495	496	497	498	499	500	501
502	503	504	505	506	507	508
509	510	511	512	513	514	

Print your name and address, detach and mail to

Editor, HEATING AND VENTILATING, 148 Lafayette St., New York 13, N. Y.

Name.....

Title (Must be shown).....

Firm (Must be shown).....

(For prompt service, title and firm name must be shown above.)

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City.....**Zone**.....**State**.....**8/47**

Abstracts AND Reviews

Publications abstracted in this department should be ordered direct from publisher.

HEAT PUMPS

It is doubtful if there is a subject in the heating and air conditioning field that is developing more interest at the present time than the heat pump. HEATING AND VENTILATING published two special sections on this subject and several articles, and therefore welcomes the compilation of data in book form by Sporn, Ambrose and Baumeister who have made extensive studies regarding the heat pump.

The subject is treated by consideration of thermodynamic principles; equipment design, specification and selection; maintenance, operating, economic and installation problems. Basic heat pump designs are described.

The authors point out that there are still many engineering and manufacturing problems to be solved before the heat pump can become a large scale economic success. However, there is an increasing number of installations and operating data from various parts of the country. Comparative costs of heating by various methods are given in the chapter on Economics of the Heat Pump. A few heat pump installations are described.

Coming at a time when many engineers are seeking authoritative information on this interesting subject, this book by three engineers prominent in the heat pump field should be very well received. It is the most complete compilation of heat pump information available and is recommended to the engineer who wants a technical treatment of the subject. Although at present much is being written about the heat pump for heating and air conditioning, it also has a wide application in the industrial field for drying, evaporation of liquids, and for the chilling and heating of process fluids.

Heat Pumps, by Philip Sporn, E. R. Ambrose, and Theodore Baumeister. Cloth bound, 5½ x 8½ in., 188 pages. Published by John Wiley & Sons, Inc., 440 4th Ave., New York 16, N. Y. Price, $3.75.

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RADIANT PANEL HEATING — In this non-technical discussion of panel heating, information is presented that may answer such questions as: What are the advantages claimed and assured of radiant panel heating? What are the disadvantages claimed and assumed of radiant panel heating? What are the relative advantages of ceiling panels, wall panels and floor panels? What are the best methods of distributing the panel surface? The material which is presented in this 36-page booklet presents no conclusions and offers no recommendations and is as unbiased as possible. It is intended primarily for architects, engineers and heating contractors who want information to enable them to compare this type of heating with other forms of heating systems. For a copy write to the Revere Copper and Brass, Inc., 230 Park Ave., New York 17, N. Y.

HOSPITAL AIR CONDITIONING—Factors which should be kept in mind when planning to air condition a hospital are contained in a four-page booklet issued as Application Data 38 by the American Society of Refrigerating Engineers. It was prepared by W. S. Bodinus, Chicago district manager of the Carrier Corp., and since 1944 Chairman of the ASRE technical committee on hospitals and institutions. For copies at 20 cents each, write American Society of Refrigerating Engineers, 40 W. 40th St., New York, N. Y.

RADIANT HEATING — A number of interesting design charts and floor plans of radiant heating systems are contained in the 40-page booklet, Rayduct, the Pipe for Radiant Heating. It describes the principal features in the design of a radiant heating installation, methods of laying out the pipe system and basic design of radiant heating. Specific buildings are covered such as the one-story structure with concrete floor slab on the ground; one-story building with wood joist construction; two-story wood frame structure with basement. It contains a chapter on general considerations in planning a radiant heating system that answers some of the questions that have been asked at meetings of heating engineers. For a copy write to Bethlehem Steel Co., Bethlehem, Pa.

HOW TO FIGURE RADIATION—Illustrated folder which presents in a step by step form, a simple method of figuring radiation and selecting boiler size for steam and hot water residential heating systems. It is based on the method of determining radiation and boiler size as recommended by the I-B-R. An extensive Btu heat loss table is based on 0F outside and 70F inside temperatures. Distributed by The National Radiator Co., Johnstown, Pa.

LESSONS IN ARC WELDING—Practical instruction in arc welding is given in the third edition of Lessons in Arc Welding. The book is based on the experience of Arthur Madson, head instructor in the Lincoln Arc Welding School. The last thirty pages of the 158-page book are devoted to questions and answers. Bound in simulated flexible leather, it is for sale by The Lincoln Electric Co., 12818 Coit Rd., Cleveland 1, Ohio. Price, 50 cents per copy.

DEGREE-DAYS FOR JUNE, 1947

HEATING AND VENTILATING's 20th Year of Publication of Monthly Degree-Day Data

City	June			Cumulative, Sept. 1, 1946 to June 30, 1947			Heating Season[1]
	1947	1946	Normal	1946-47	1945-46	Normal	Normal
Abilene, Texas	0	0	0	2838	2388	2061	2061
Albany, New York	81	108	0	6710	6886	6580	6580
Albuquerque, New Mexico	9	0	0	4298	4242	4298	4298
Alpena, Michigan	206	191	138	8055	7826	8265	8299*
Anaconda, Montana	383	265	251	8440	7773	8261	8357**
Asheville, North Carolina	18	19	0	4093	3960	4232	4232
Atlanta, Georgia	7	0	0	2880	2778	2890	2890
Atlantic City, New Jersey	46	63	0	4565	4529	5176	5176
Augusta, Georgia	1	0	0	2192	2104	2161	2161
Baker, Oregon	267	225	213	6880	6951	7163	7163
Baltimore, Maryland	5	18	0	4076	4034	4533	4533
Billings, Montana	187	91	60	7498	6464	7119	7119
Binghamton, New York	68	122	254	6220	6432	6808	6808
Birmingham, Alabama	1	4	0	2784	2652	2352	2352
Bismarck, North Dakota	118	88	45	9047	8798	9192	9192
Block Island, Rhode Island	158	128	99	5427	5658	5788	5788
Boise, Idaho	127	59	0	5906	5685	5552	5552
Boston, Massachusetts	86	74	0	5495	5776	6045	6045
Bozeman, Montana	311	225	230	8016	7855	8425	8521**
Buffalo, New York	76	128	12	6527	6588	6822	6822
Burlington, Vermont	121	127	3	7491	7734	7514	7514
Butte, Montana	372	240	236	8846	8268	8162	8235**
Cairo, Illinois	0	5	0	3783	3422	3909	3909
Canton, New York	108	160	0	7822	8054	8020	8020
Charles City, Iowa	(a)	88	0	(a)	7253	7588	7588
Charleston, South Carolina	0	0	0	1724	1737	1769	1769
Charlotte, North Carolina	0	1	0	3028	2887	3120	3120
Chattanooga, Tennessee	2	5	0	3435	3180	3118	3118
Cheyenne, Wyoming	264	148	126	7731	7060	7466	7466
Chicago, Illinois	121	95	59	6113	5899	6077	6077
Cincinnati, Ohio	5	13	0	4472	4359	4684	4684
Cleveland, Ohio	66	76	0	5919	5679	6155	6155
Columbia, Missouri	9	30	0	4895	4494	4922	4922
Columbia, South Carolina	1	0	0	2297	2269	2364	2364
Columbus, Ohio	23	28	0	5243	5048	5398	5398
Concord, New Hampshire	144	134	54	7324	7569	7353	7353
Concordia, Kansas	37	33	0	5569	4779	5315	5315
Dallas, Texas	0	0	0	2476	2103	2256	2256
Davenport, Iowa	58	52	0	6097	5933	6289	6289
Dayton, Ohio	41	31	0	5709	5493	5264	5264
Denver, Colorado	130	67	0	5991	5291	5874	5874
Des Moines, Iowa	61	53	0	6412	5928	6384	6384
Detroit, Michigan	87	88	0	6367	6176	6490	6490
Devils Lake, North Dakota	166	113	96	10,006	9982	9970	9970
Dodge City, Kansas	32	40	0	5304	4539	5035	5035
Dubuque, Iowa	83	67	0	6711	6460	6790	6790
Duluth, Minnesota	301	233	216	9591	9336	9483	9483
Eastport, Maine	333	278	300	7630	7986	8241	8520**
Elkins, West Virginia	78	64	0	5796	5577	5697	5697
El Paso, Texas	0	0	0	2708	2538	2428	2428
Ely, Nevada	275	163	(a)	7632	7726	(a)	(a)
Erie, Pennsylvania	73	98	0	5918	5855	6273	6273
Escanaba, Michigan	227	181	138	8529	8207	8746	8771*
Evansville, Indiana	5	21	0	4667	4305	4244	4244
Fort Smith, Arkansas	0	7	0	3336	3069	3147	3147
Fort Wayne, Indiana	77	71	0	6316	6191	5925	5925
Fort Worth, Texas	0	3	0	2532	2158	2148	2148
Fresno, California	0	0	0	2552	2435	2334	2334
Galveston, Texas	0	0	0	1407	1045	1016	1016
Grand Junction, Colorado	73	7	0	5727	5484	5548	5548
Grand Rapids, Michigan	93	82	0	6460	6293	6535	6535
Green Bay, Wisconsin	160	136	0	7904	7722	7825	7825
Greensboro, North Carolina	2	13	0	3760	3698	3529	3529
Greenville, South Carolina	6	1	0	3081	3053	3380	3380
Harrisburgh, Pennsylvania	21	50	0	5118	5148	5375	5375
Hartford, Connecticut	72	74	0	5881	6242	6036	6036
Hatteras, North Carolina	0	0	0	2252	2407	2571	2571
Havre, Montana	146	121	144	8747	7591	8700	8700
Helena, Montana	272	169	171	8159	7227	7834	7894**
Houston, Texas	0	0	0	1489	1188	1157	1157
Huron, South Dakota	81	86	0	8026	7769	8004	8004
Indianapolis, Indiana	30	28	0	5202	5015	5298	5298
Jackson, Mississippi	0	1	(a)	2233	2076	(a)	(a)
Kansas City, Missouri	11	27	0	4880	4389	4956	4956
Kewanee, Illinois	33	64	10	6074	5864	6139	6139
Knoxville, Tennessee	3	8	0	3658	3362	3670	3670
La Crosse, Wisconsin	100	88	0	7748	7505	7322	7322
Lander, Wyoming	283	114	135	8065	7518	7947	7947

[1]Figures in this column are normal totals for a complete heating season, September to June, incl.

Figures in this table, with nine exceptions, based on local weather bureau reports. Exceptions are Utica, Lewiston, Kewanee, Sioux City, and Jackson, figures for which are furnished through the courtesy of Coke Sales Department, Central New York Power Corp., Utica, N. Y.; Norman E. Ross, Bursar, Bates College, Lewiston, Me.; J. M. Hartman, Engineering Department, Kewanee Boiler Corp., Kewanee, Ill.; Alfred R. Wagstaff, Engineer, Sioux City Foundry and Boiler Co., Sioux City, Iowa, and H. M. Ludlow, Box 1368, Jackson, Miss., respectively; Anaconda, Bozeman, Butte and Livingston, Mont., through the courtesy of the Montana Power Company.

[Table concluded on Page 108]

Degree-Days for June, 1947 (Concluded)

HEATING AND VENTILATING's 20th Year of Publication of Monthly Degree-Day Data

City	June			Cumulative, Sept. 1, 1946 to June 30, 1947			Heating Season[1]
	1947	1946	Normal	1946-47	1945-46	Normal	Normal
Lansing, Michigan	120	127	0	6901	6804	7048	7048
Lewiston, Maine	163	122	45	7511	7825	7707	7707
Lincoln, Nebraska	43	44	0	5898	5229	5999	5999
Little Rock, Arkansas	0	3	0	3102	2856	2811	2811
Livingston, Montana	0	207	142	....	6955	7185	7245**
Los Angeles, California	5	0	0	1340	1417	1504	1504
Louisville, Kentucky	3	16	0	4280	3942	4180	4180
Lynchburg, Virginia	13	12	0	4171	4069	3980	3980
Macon, Georgia	1	0	0	2287	2176	2201	2201
Madison, Wisconsin	121	93	0	7270	7086	7429	7429
Marquette, Michigan	296	221	186	8665	8232	8650	8693*
Memphis, Tennessee	0	4	0	3152	2977	2950	2950
Meridian, Mississippi	0	2	0	2347	2113	2160	2160
Milwaukee, Wisconsin	189	149	39	7359	6957	7245	7245
Minneapolis, Minnesota	98	84	0	7986	7750	7850	7850
Modena, Utah	133	50	42	6295	6276	6562	6562
Montgomery, Alabama	0	0	0	1963	1925	1884	1884
Nantucket, Massachusetts	207	171	123	5730	5797	5957	5957
Nashville, Tennessee	3	12	0	3658	3410	3507	3507
New Haven, Connecticut	91	96	0	5731	6037	5895	5895
New Orleans, Louisiana	0	0	0	1219	1108	1024	1024
New York, New York	34	48	30	4867	4933	5274	5274***
†Nome, Alaska	807	946	973	13,079	13,288	13,058	14,580**
Norfo'k, Virginia	4	5	0	3073	3068	3350	3350
North Head, Washington	235	282	309	4743	4977	5002	5452**
North Platte, Nebraska	84	67	0	6434	5645	6366	6366
Oakland, California	61	155	93	2938	3280	2963	3143**
Oklahoma City, Oklahoma	3	14	0	3604	3147	3613	3613
Omaha, Nebraska	45	47	0	6187	5619	6131	6131
Oswego, New York	145	146	63	6673	6841	7088	7088
Parkersburg, West Virginia	14	18	0	4667	4481	4775	4775
Peoria, Illinois	48	46	0	6069	5839	6109	6109
Philadelphia, Pennsylvania	15	38	17	4420	4479	4737	4737***
Phoenix, Arizona	0	0	0	1278	1479	1405	1405
Pittsburgh, Pennsylvania	36	36	0	5389	4881	5235	5235
Pocatello, Idaho	187	84	60	6757	6873	6655	6655
Portland, Maine	(a)	163	81	(a)	7706	7218	7218
Portland, Oregon	96	119	90	3923	4070	4469	4469
Providence, Rhode Island	72	54	0	5304	5515	6015	6015
Pueblo, Colorado	67	27	0	5939	5319	5514	5514
Raleigh, North Carolina	0	5	0	3104	3130	3234	3234
Rapid City, South Dakota	194	125	30	7805	6646	7118	7118
Reading, Pennsylvania	20	53	0	4881	4963	5389	5389
Red Bluff, California	6	0	(a)	2563	2716	(a)	(a)
Reno, Nevada	156	150	90	5681	5759	5892	5892
Richmond, Virginia	4	4	0	3619	3617	3695	3695
Rochester, New York	80	113	0	6530	6718	6732	6732
Roseburg, Oregon	133	117	114	4229	4073	4428	4428
Roswell, New Mexico	0	0	0	3479	3193	3484	3484
Sacramento, California	6	6	0	2683	2625	2653	2653
St. Joseph, Missouri	15	33	0	5272	4807	5161	5161
St. Louis, Missouri	6	19	0	4507	4155	4585	4585
Salt Lake City, Utah	96	39	0	5852	5679	5555	5555
San Antonio, Texas	0	0	0	1844	1514	1202	1202
San Diego, California	0	0	6	1340	1365	1645	1645
Sandusky, Ohio	67	53	0	5773	5624	6208	6208
San Francisco, California	116	192	195	2748	2847	2876	3264**
Sault Ste. Marie, Michigan	269	266	189	9212	9044	9139	9285**
Savannah, Georgia	0	0	0	1585	1581	1490	1490
Scranton, Pennsylvania	50	91	0	5856	5906	6129	6129
Seattle, Washington	109	150	162	6207	4300	4857	4934**
Sheridan, Wyoming	(a)	137	120	(a)	6948	8008	8008
Shreveport, Louisiana	0	0	0	2272	2039	1938	1938
Sioux City, Iowa	71	72	0	7198	6617	6898	6898
Spokane, Washington	129	159	81	6358	6193	6355	6355
Springfield, Illinois	17	40	0	5230	4901	5373	5373
Springfield, Missouri	12	30	0	4694	4248	4428	4428
Syracuse, New York	83	123	12	6581	6742	6893	6893
Tacoma, Washington	144	185	183	4738	4728	5066	5181**
Terre Haute, Indiana	26	23	0	5156	4780	4872	4872
Toledo, Ohio	78	76	0	6282	6155	6077	6077
Topeka, Kansas	14	26	0	4997	4373	4969	4969
Trenton, New Jersey	30	48	0	4808	4923	4933	4933
Utica, New York	85	142	0	6088	7703	6796	6796
Valentine, Nebraska	109	97	0	7378	6454	7039	7039
Walla Walla, Washington	41	64	0	4623	4482	4808	4808
Washington, D. C.	2	11	0	4038	4039	4626	4626
Wichita, Kansas	13	27	0	4740	4140	4673	4673
Williston, North Dakota	162	113	54	9346	8857	9323	9323
Winnemucca, Nevada	141	69	117	5931	5963	6391	6427**
Yakima, Washington	70	88	0	5541	5127	5599	5599

(a) Data not available.
†Nome data are for May.

*Includes August.
**Includes July and August.
***New 48-year normal covering 1898 to 1946.

[1]Figures in this column are normal totals for a complete heating season, September to June, incl.

AN EXAMPLE:

This is a diesel engine exhaust manifold outlet fabricated with Tube-Turn welding fittings taken out of regular stock. Replacing castings—eight such outlets to an engine save .71 lbs. per horsepower. Seems little, but multiply this by 1000 and you have 710 pounds of dead weight eliminated.

"It can be done!"

SO MANY piping problems are solved with the use of welding fittings that it pays to see your Tube-Turn Distributor first. He handles *the fitting that becomes part of the pipe.*

Tube-Turn welding fittings—engineered in design, built with closer tolerances than code requirements, available in a wide variety of styles, sizes and materials—often offer just the right answer to what sometimes seems an impossible problem. Welding fittings for example, permit extremely close nesting without flow loss. Tube-Turn welding fittings have uniform wall thickness and full circularity which allows them being cut and used at odd angles. Order one, one-hundred, or a thousand Tube-Turn welding fittings of the same size and part number and they will be dimensionally uniform. They can be and are being used in production line assembly of equipment.

For full information about the more than 4000 types and sizes in the complete line of Tube-Turn welding fittings and flanges—for details about the wide range of special metals and alloys—for the name of your nearest distributor, write to—

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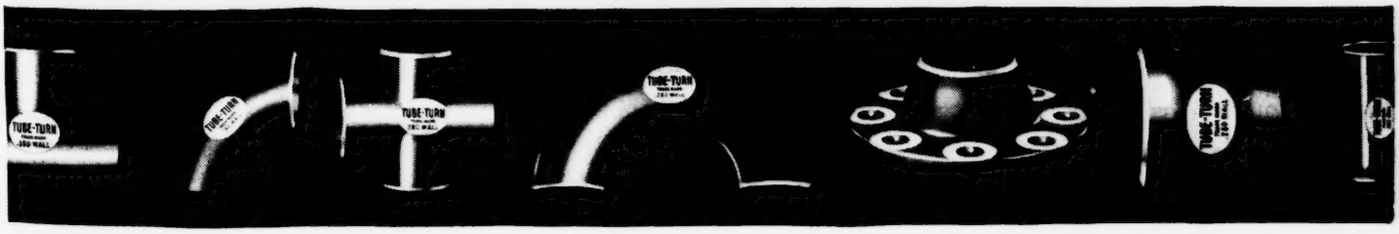
District Offices at New York, Washington, D. C., Philadelphia, Pittsburgh, Detroit, Chicago, Houston, San Francisco, Los Angeles.

TUBE-TURN TRADE MARK **tt** *Welding Fittings and Flanges*



NEWS OF THE MONTH

SHIFT TO OIL

by householders and industry puts load on production facilities while steel shortage prolongs distribution tieup.

Headlines regarding the fuel oil situation present a confusing alternation between reports of peak production and threatened shortage.

• **RATIONING.**—Two days before announcement of the seventh consecutive week of peak crude production beyond the 5-million-barrel-a-day mark, one company (Standard Oil Co. of Indiana) announced a plan for gasoline allocation entailing informal rationing to filling stations to be effective in 12 midwestern states. The reason for Standard's shortage was inadequate pipelines and greatly increased highway travel. The company also credits large scale increases in farm mechanization with considerable influence upon shortages in that area. Oil men in the east described the situation as a "little tight" but far from "critical."

At about this time, Secretary of the Interior James A. Krug spoke of widespread local shortages of gasoline and fuel oil and said that general shortage in the fall and winter is a possibility. He gave the maritime strike and the steel shortage as chief causes of the threatened oil shortages.

• **DISTRIBUTION.**—Distribution and storage facilities are the real bottleneck, according to OHI, and behind these lies the ubiquitous steel shortage. A. E. Whitehall, national secretary of OHI's distribution division, points out that it takes steel to build tank cars, barges, pipelines, and bulk storage facilities. High crude production can have little effect in allaying local shortages of refined products, he said, while storage and distribution facilities are inadequate to cope with growing demand—especially in the light fuel and Diesel oil classes.

• **DEMAND.**—One graphic barometer of fuel oil demand is the Bureau of the Census report on oil burner shipments as of May, 1947. Factory shipments of oil burners in May totaled 98,410 units, according to the Bureau. These shipments were slightly less than the 99,380 burners shipped in April, but amounted to almost three times the number shipped in May of 1946. Of the total number of oil burners shipped in May 1947 the residential type oil burners accounted for 94,342, or 96% while the remaining 4,068 units, or 4%, were commercial and industrial types. Fig. 1 shows the trend of shipments graphically.

Data for May were compiled from reports submitted by 160 oil burner manufacturers. The information on furnace burner units, boiler burner units, and water heating units includes only units produced by manufacturers of oil burners.

The data in this report refers only to oil burners and oil burner units consuming fuel oil of Commercial Standard No. 1 grade or heavier, used in central heating plants, in industrial process equipment such as heat-treating furnaces and industrial ovens, and for the generation of steam for power. The statistics do not include burners of the range type. A summary is presented in Table 1.

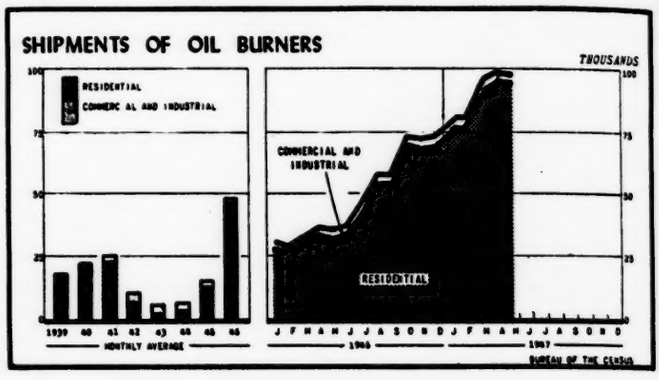


Fig. 1. Trend of oil burner shipments as of May, 1947.

Table 1 – Oil Burners: Summary of Production, Shipments, Stocks, and Orders

(Number of burners)

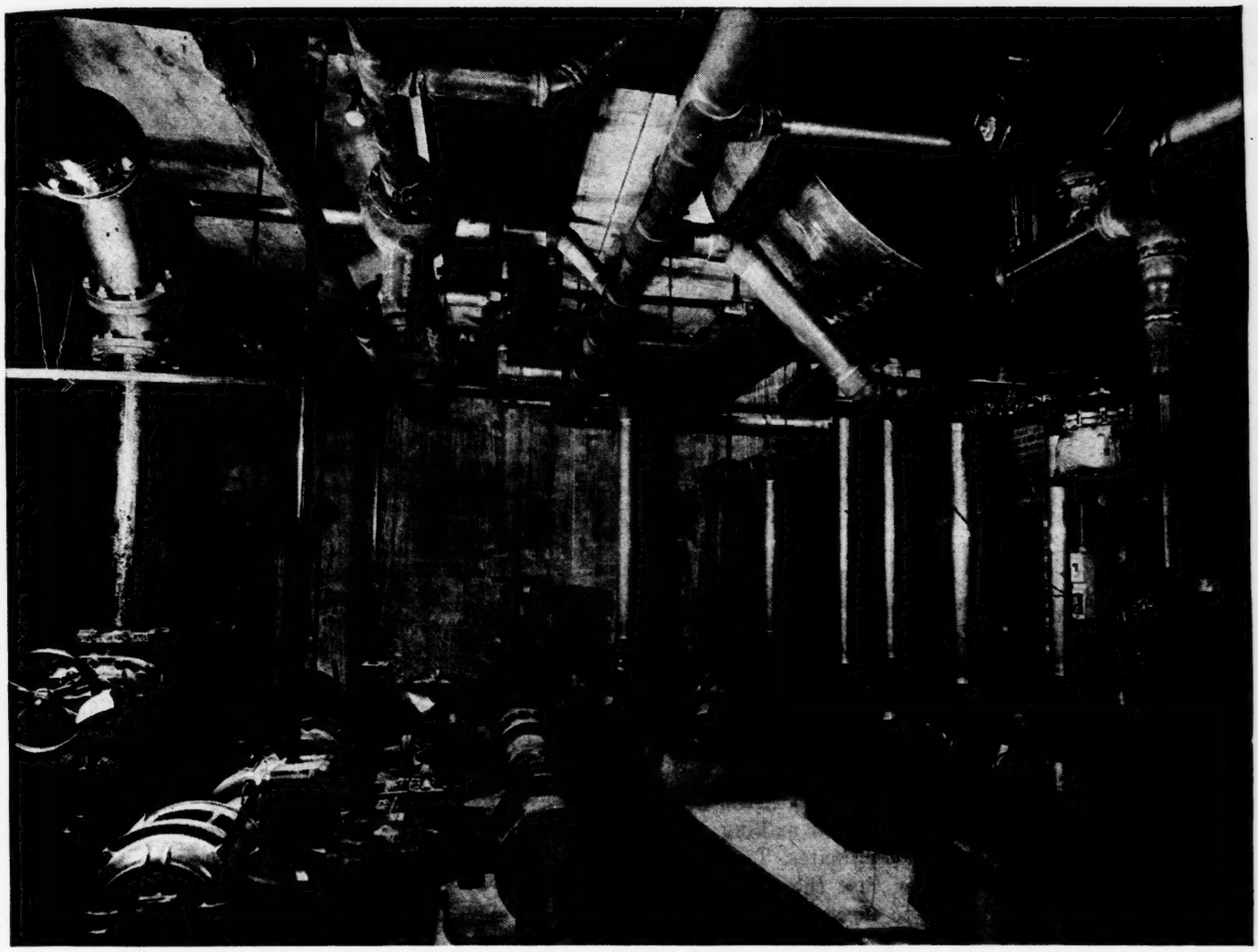
Item	1947		1946 May	Total, 5 Months January-May	
	May	April		1947	1946
Production	100,506	97,972	35,427	465,562	161,837
Shipments	98,410	99,380	35,089	457,168	161,869
Stocks, end of month	15,432	13,337	6,134	...	...
New orders received during month (less cancellations)	5,083	—10,338[1]	169,402	212,720	620,905
Unfilled orders, end of month	874,787	968,114	736,347	...	...

[1]Cancellations exceeded new orders during month.

HOT WEATHER

limits hard work, according to Army Quartermaster tests at Indiana University.

The Army wanted to know how much work soldiers can perform in hot climates without danger and the effect of clothing on the amount of work that can be done. So the Department of Physiology of Indiana University's Medical School conducted some investigations for the Quartermaster Corps. It turned out that men in good physical condition and accustomed to the



Insure Unrestricted Flow with REVERE COPPER WATER TUBE

FRICTION caused by rust accumulations inside the lines can materially lower the efficiency of forced circulation heating systems. Such installations derive full benefit from the permanently smooth interior of Revere Copper Water Tube. This tube is 99.9% pure copper, seamless and cold-drawn with a gun-barrel finish inside. Since it will not rust, it permits full and unrestricted flow of water throughout years of continuous service.

In any heating, water-supply or air-conditioning installation—for a large industrial plant or a small home—*trouble always costs more than Revere Copper Water Tube.* This tube is ideal for these and other piping services in all types and sizes of buildings. Joints are easily made with either soldered or compression fittings . . . and even the hard temper Type K tube, in sizes up to 1" inclusive, is easy to bend by means of a hand-operated tool.

Revere Copper Water Tube is stamped at regular intervals with the Revere name and the type. Look for these identification marks—they insure full wall thickness and the close gauge tolerances so essential for tight sweated joints.

You can specify or install, in addition to Revere Copper Water Tube, such other long-lived Revere materials as Red-Brass Pipe; Sheet Copper for tanks, ducts, pans and trays; Dryseal Copper Refrigeration Tube (dehydrated and sealed); Copper oil burner, heat control and capillary tubes.

Revere materials are handled by Revere Distributors in all parts of the country. The Revere Technical Advisory Service, Architectural, is always ready to serve you. Call your Revere Distributor.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

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Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; New Bedford, Mass.; Rome, N. Y.—Sales Offices in Principal Cities, Distributors Everywhere.

tropics could work for six hours without discomfort even though they were wearing tropical uniforms.

• **TREADMILL.**—The soldiers who submitted to the test did not dig dirt or engage in other manual labor. They walked on a motor-driven treadmill up a 2.5% grade at a speed of 3.5 miles an hour. The temperature was 91.5F D.B. and 89.2F W.B. This was a pretty severe test.

The scientists in charge measured everything and made allowances for everything. Thermocouples were attached to different parts of the body to record exact temperatures. The men were permitted to drink water enough with 0.1 per cent dissolved salt to compensate for sweating and the rate and amount of sweating were determined to the fraction of a gram.

• **CLOTHING.**—Under extremely high temperature and humidity, the men worked at a rate equivalent to the development of .07 Btu per sq ft of skin per hour. They sweated profusely during the first hours but less and less as the test continued, until finally the body temperature rose to the danger point—that is, the point beyond which heat prostration was likely to occur.

As might be expected, men clad in shorts, socks and shoes maintained thermal equilibrium at a temperature and humidity too high for men who wore the tropical uniform. It was only when the work was reduced that the men who were clothed continued through the sixth hour.

All this means that there is danger in making men work for prolonged periods in hot climates. The rates of sweating might decline so far that the production of sweat would be insufficient to meet body requirements, and body temperatures might rise to the point of heat stroke.

More than 80% of those who succumbed to heat in the tests were from the northern half of the United States and therefore not yet acclimated to high temperatures. Stout men were more susceptible to heat stroke than thin men.

• **HUMIDITY.**—The Army's tests showed that if the humidity is high enough even a temperature not very much above 70F may be dangerous. In fact, high humidity at 70F is much harder to bear than a temperature of 103F with low humidity.

LOW TEMPERATURE COKE

to be processed in a $3,000,000 coal conversion plant and tar refinery to be built near Pittsburgh.

The Disco Co. subsidiary of Pittsburgh Consolidation Coal Co. will build a $3 million plant for the manufacture of its smokeless solid fuel produced from coal fines and marketed under the trade name of "Disco". Included in the plant will be a tar refinery for recovery of coal-tar chemicals. Construction is to begin immediately and production from the new commercial plant is expected by October 1948.

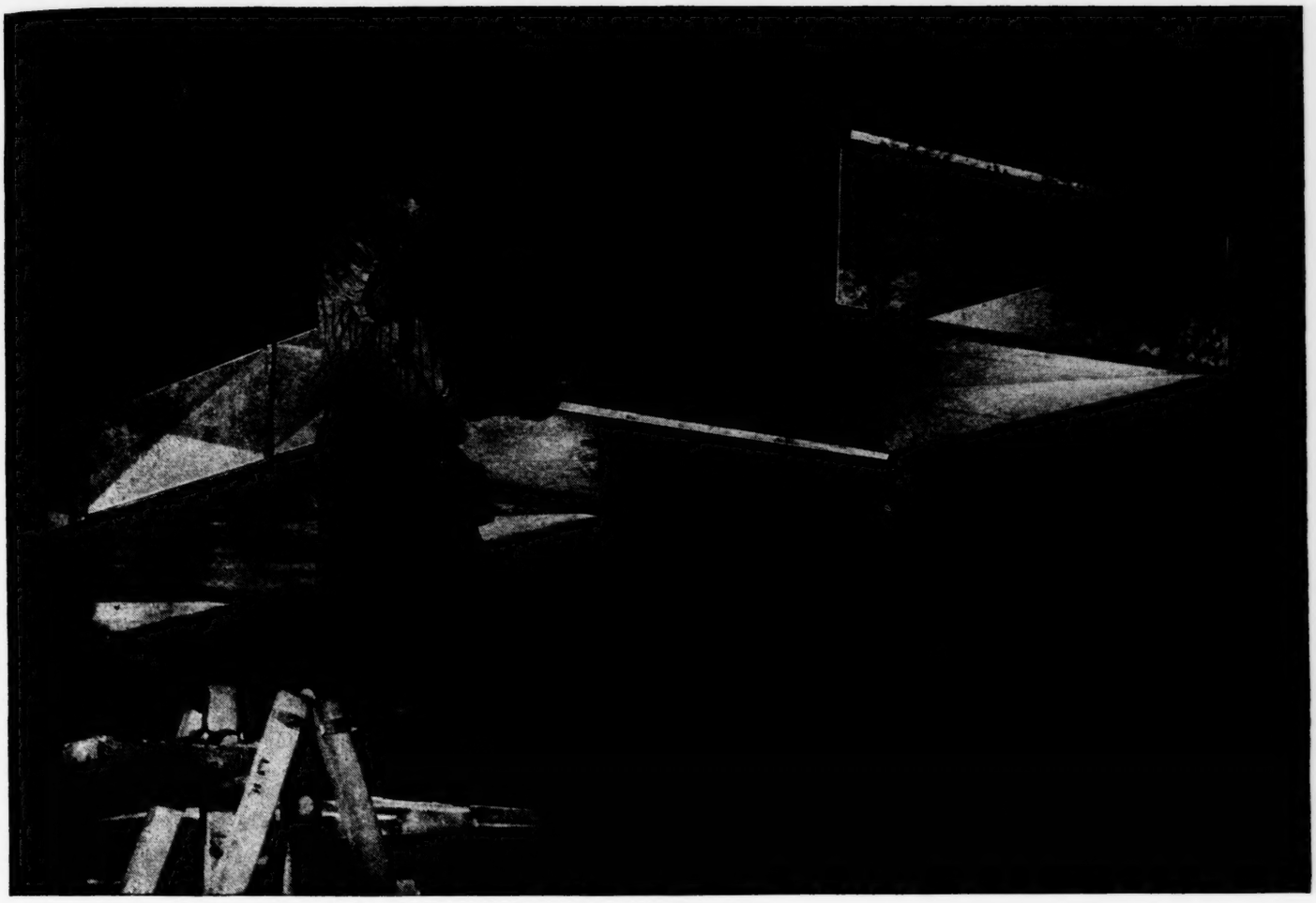
Inspecting a stock pile of Disco made at low temperatures from bituminous fines.

• **CAPACITY.**—The new plant will be equipped with seven unit carbonizers with a total daily production capacity, under present operating practice, of 750 tons of Disco and will process about 1,000 tons of high volatile coal fines of any rank as the raw material. The present Disco plant, containing three production units of smaller capacity, will continue producing its monthly average of 6,000 tons of this low temperature coke until the new plant is ready to begin operations, at which time the older facilities will be dismantled.

Site of the new plant will adjoin the present small-scale unit, which is near McDonald, Pa., about 20 miles west of Pittsburgh and adjacent to the large Champion coal cleaning plant operated by Pittsburgh Coal Co.

• **THE PRODUCT.**—Disco is reported to be the only ball-type low temperature coke produced commercially by a continuous process. It is heavier than high temperature coke and differs from the latter in a number of respects. As experienced at the present plant, Disco ash runs from 10% to 11%, and volatile content of the final product ranges from 15% to 17%. Disco has a high shatter index: 70% for plus-2-inch material. The balls range in size from 1 to 8 inches in diameter. The product is dense, with an apparent specific gravity of 0.85 and is uniform in cell structure.

• **BY-PRODUCTS.**—Among the by-products to be produced by the new plant will be an important yield of approximately 15 gallons of tar from each ton of coal charged. A high tar-acid content gives special value to the yield of tar, which will be fractionated in a tar plant. There will also be the production of some gas but this gas will be used as fuel to heat the carbonizing retorts. So far as is known at present, the company has not yet planned to recover the light oils or to treat the liquors for organic chemicals. Research is now under way for eventual recovery of such materials.



Durable Ductwork

for industrial air-conditioning

A textile factory, a chemical plant and a printing establishment all present different air-conditioning problems from the engineering standpoint. But they all require rugged ductwork that will give maximum service under corrosive conditions.

Beth-Cu-Loy Galvanized Steel Sheets have the properties needed for this type of service.

First, they have the strength, rigidity and fatigue-resistance found only in steel. Second, they have high corrosion-resistance due to their copper content and their coating of Prime Western zinc. And as far as their cost is concerned Beth-Cu-Loy Galvanized Sheets are priced at little more than ordinary galvanized steel sheets.

Consider these points of superiority in Beth-Cu-Loy. They give greater customer satisfaction and help create the goodwill that builds business for the future.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation

Beth-Cu-Loy Galvanized Sheets

BETHLEHEM STEEL

Before the new Garden air conditioning system was installed, with electronic precipitators, a contest might look like this through a haze of smoke. Wide World photos.

John Reed Kilpatrick, president of Madison Square Garden, inspects a new air diffuser in the top-most gallery.

MADISON SQUARE GARDEN

has new air conditioning system with unique engineering features and electronic smoke removal.

Eight separate air handling systems supply and return over 2,500,000 cu ft of air at 76F every hour in Madison Square Garden's new million-dollar air conditioning system. That's over 30 cfm per person for a capacity audience in New York's huge arena.

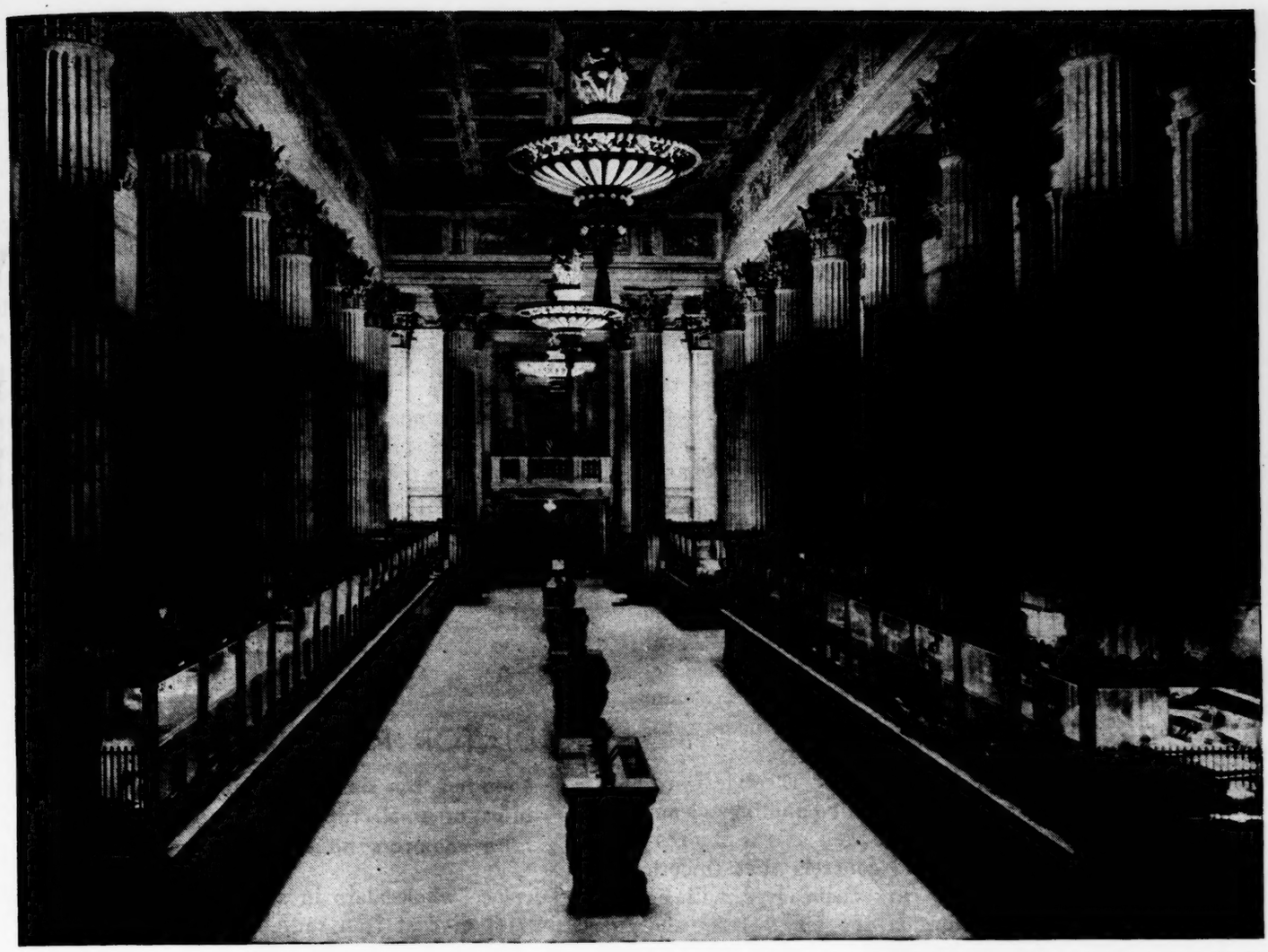
• **SMOKE.** — One of the big problems in this exceptional engineering project was removal of the dense cloud of tobacco smoke that collected with ever increasing thickness under the 75-ft ceiling during an average evening's entertainment. It was found that simple side-wall exhaust merely diluted the fringes of this smoke cloud which hung like a gigantic inverted mushroom to obscure the vision and pollute the breathing zone of the audience.

Charles H. Leopold, consulting engineer of Philadelphia, designer of the new air conditioning system, provided a double-barreled solution to the problem. First, he installed electronic precipitators to the extent of two power-packs for each of the eight supply systems. These remove practically all of the smoke and dust from the air supplied to the arena. Second, Mr. Leopold devised a means of breaking up and moving the inverted mushroom of smoke so that it could be picked up and exhausted by the return grilles in the side walls. This he accomplished by a system of eight inverted cones, each 8 ft wide at the mouth, 12 ft deep, and 4 ft in diameter at the throat. These cones are set flush with the ceiling and are connected by a dampered duct to a supply air plenum. When the supply fans are on at full capacity, the damper opens and each cone injects 15,000 cfm downward into the smoke cloud. A system of vanes in the throat of each cone directs the downward air stream in such a manner that no perceptible draft reaches the audience, but the arena's central core of air is agitated and moved in the direction of the return grilles located at three levels in the side walls.

• **AIR HANDLING.**– Each of the eight supply fans is rated at 52,275 cfm and operates at any of three speeds. Eight return air fans of similar capacity are supplemented by two 100,000-cfm exhaust fans located front and rear of the building. Chilled water at 42F cools the supply air which is then washed, re-heated, and admitted to the arena at 76F D.B. and 54.5% R.H. Supply grilles are at three levels in the side walls and air diffusers supply and circulate cooled air at the top level.

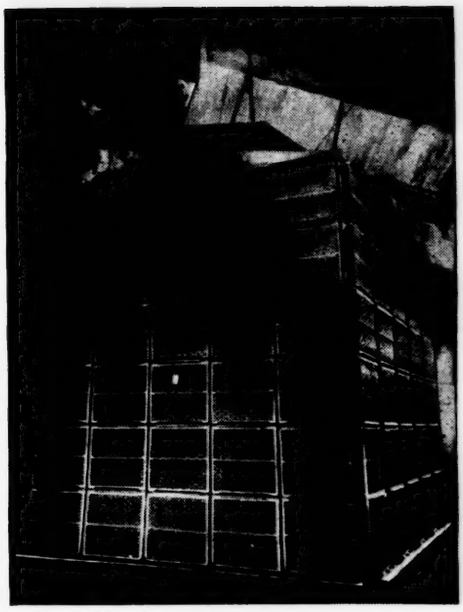
• **REFRIGERATION.**—The new system doubles the refrigerating capacity of the old ice making equipment which was installed for skating events. There are now six centrifugal, steam-turbine-operated compressors with a combined capacity of 1,335 tons of refrigeration. Four 75-hp chilled water pumps move 1,350 gpm each of chilled water at 42F against a head of 175 ft. Five condenser pumps of 20 to 30 hp each have capacities as high as 750 gpm at 120 ft of head. Three 40-hp brine pumps are rated at 875 gpm at 105 ft of head. About 3000 hp are required to operate the whole system. A cooling tower for condenser water will cool about 3,000 gpm from 105 to 85F.

• **OPERATION.**—The entire system is controlled from a central panel in the chief engineer's office. In direct supervision of the installation is Richard Donopria, plant superintendent for the Garden. A resident consulting engineer, Bruce Olson, from the office of Charles Leopold, will remain on the job at the Garden until smooth operation by Garden personnel is assured. He will then act as consultant for an indefinite period.



DUST-STOPS* FILTER THE AIR

for The National City Bank of Cleveland



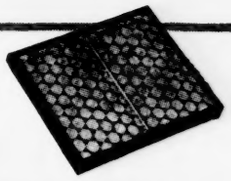
Down in the subbasement, two floors below street level, is a bank of DUST-STOP Air Filters. Outside air is taken in from the roof and drawn through the filters. Thus the main banking floor and the offices on the upper floors are provided with ample filtered air the year around—either heated or cooled.

The efficient, low-cost DUST-STOP Air Filters are replaced on a rotating basis. A section of the filters is changed each day. This system, therefore, requires a minimum amount of maintenance time and cost to be kept at top efficiency.

DUST-STOP Air Filters are used in large and small commercial and industrial heating, ventilating or air-conditioning systems. They may be installed in custom-built or the complete, ready-to-assemble, steel frame cells—*to handle any cfm of air required.* Maintenance is easy, economical. DUST-STOPS are readily available from suppliers in nearly every community.

See Sweet's Files for complete information or write for booklet —"Air Filtration in Central Systems" (A5.2.1). Owens-Corning Fiberglas Corporation, Department 912, Toledo 1, Ohio. Branches in principal cities.

In Canada: Fiberglas Canada Ltd., Toronto, Ontario.



DUST STOP* AIR FILTERS

*T. M. REG. U. S. PAT. OFF.

—a FIBERGLAS product

SUBWAY AIR

to be electrically cleaned and sterilized in ten-car Utopia for N. Y. straphangers.

Science is coming to the aid of New York's millions of congested subway straphangers. Soon they may be reading their morning papers under glareless fluorescent lights, breathing electronically-cleaned and germ-freed air, and starting and stopping with the smoothness of a canoe on a lake.

• **TEN-CAR LAB.** — This approaching millenium is heralded in the announcement of details of a new ten-car laboratory subway train recently ordered by the city's Board of Transportation and expected to be in service late in 1948. The new train will serve as a traveling proving ground for the Board to test newest types of subway equipment in scheduled service on regular subway routes.

Design of the deluxe new stainless steel train was based on five principles the Board of Transportation has laid down for all its new subway cars. These are: (1) reduction in noise; (2) faster and smoother acceleration and deceleration; (3) jerkless stops and starts; (4) dirt-free braking; and (5) modern interior and exterior design.

• **AIR HANDLING.**—The Westinghouse Electric Corp. will supply all the train's special air-handling, cleaning and sterilizing equipment, as well as the fluorescent lighting and the electrical controls that smooth out starts and stops. The cars themselves will be standard size for operation on the city's IND and BMT Divisions, but will have new interior arrangements and decoration and wider doors than present cars. They are being built by the Edward G. Budd Manufacturing Company in Philadelphia.

Each car of the ten-car train will have two complete, automatic, air-handling systems; one to recirculate electronically cleansed and sterilized air, and the other to bring fresh, sterile air into the car.

All new fresh air being drawn into the car, and all recirculated air, will be blown past groups of Sterilamps, whose invisible ultraviolet rays will kill 95 to 100% of the air-borne bacteria.

• **CLEANED AIR.**—In addition to the Sterilamp treatment, the 3,000 cfm of incoming fresh air will also be subjected to two separate dirt-removal processes. The first is a series of cyclonic cells in which the air is whirled rapidly so that centrifugal force throws out all large dirt particles. The air then speeds through the Precipitron, an electrostatic dust precipitator developed in the Westinghouse Research Laboratories. Here dirt particles down to 1/250,000 in. are given a high electrical charge as they pass through the ionizer. They are then pulled from the airstream when they pass between a series of electrically-charged metal plates.

The recirculating air system, which draws air from the ends of the cars and redistributes it from a series of draftless ceiling vents, will handle a normal volume of more than 5,000 cfm per car. However, in warm weather, or when the car temperature rises because of crowding, automatic thermostatic controls will double the power output of the blower motors, and boost air circulation to 6,640 cfm. Thus, all the air in the car will be recirculated and germ-freed approximately every 40 seconds.

Fresh air will be taken in through grilles in the roof over the motorman's cabs at both ends of the car, and led through ducts to the Precipitron and Sterilamp equipment, which will be mounted under the car. It will then be distributed the length of the car through diffusers mounted under the seats. In winter, it will also be heated electrically as it passes through these diffusers.

• **LIGHT.**—Cars of the new train will be lighted with fluorescent lamps mounted in special ceiling fixtures, and will provide 17 foot-candles of light at seated reading levels, compared with the average of 5 foot-candles with present incandescent lamps. The subway system route maps in the sidewall panels of the cars will be specially illuminated.

RADIATOR PRODUCTION

speeded by simplified practice. Stock assemblies of small tube units cut by 40%. Large tube radiators no longer manufactured.

To place wholesalers in a position to obtain better deliveries of cast iron radiators, and to obtain more rapid turnover of their stock. Simplified Practice Recommendation No. 174-47 has been issued by the National Bureau of Standards, with the approval of manufacturers of cast iron radiators.

• **ASSEMBLIES.**—An industry study of the variations in radiator assemblies sold in 1940 and 1941 revealed that from a total of more than 800 possible combinations of heights, tubes and sections, 60 of such combinations would take care of more than 90% of building requirements.

Publication of this recommendation does not restrict the production of any assembly which may be needed for specific jobs. However, the manufacturers are assisted in making more prompt deliveries when production is concentrated on the popular sizes of assemblies. The wholesaler is likewise able to maintain stocks that are more free of slow-moving items if he purchases a limited variety of assemblies which will take care of all normal demands.

• **LARGE TUBE.**—Large tube cast iron radiators are no longer being manufactured, except for repair sections. An order of the War Production Board in 1942 prohibited the manufacture of large tube cast iron radiators in order to conserve pig iron which was then a critical material. Since small tube radiators offer the same heat output and occupy only 60% as much space, manufacturers find complete acceptance of that more attractive type and are concentrating their production facilities on small tube.

• **COMMITTEE.** — Simplified Practice Recommendation No. 174-47 is in charge of a standing committee

Illustration shows Timken Silent Automatic Wall-Flame Oil Burner Unit which has been finished with Dimenso.

...WITH A FAMOUS FINISH!

DIMENSO

(PATENTED)

It's a cinch to get beautiful, 2-color HAMMERED FINISHES on Heating and Ventilating Units with Dimenso!

ONE GUN sprays any 2-color combination.

ONE BAKING on clean bare metal gives you wonderful HAMMERED FINISHES. Infinite variety, too!

ECONOMICAL Dimenso finishes can be obtained quickly, easily with patented Dimenso gun. Fast spraying —production costs reduced 30%— 2 colors at once—all add up to *low unit cost!*

Representative will gladly call—no obligation.

FREE Dimenso Finish Booklet . . . contains actual finish samples. Write the Sherwin-Williams Co., Cleveland 1, Ohio. (*Export Division, Newark, N. J.*)

PRODUCT OF SHERWIN-WILLIAMS RESEARCH

SHERWIN-WILLIAMS INDUSTRIAL FINISHES

which was appointed by the industry to maintain the simplified schedule abreast of changing conditions. It is composed of L. N. Hunter, the National Radiator Co., Johnstown, Penn., chairman; R. E. Daly, American Radiator and Standard Sanitary Corporation, Pittsburgh, Penn., W. C. Murray, Utica Radiator Corporation, Utica, New York; Maurice R. Colbert, Maurice J. Colbert Co., Washington, D. C.; Harry M. Hart, L. H. Prentice Co., Chicago; and Leon L. Munier, Wolff & Munier, Inc., New York.

The simplification program in the cast iron radiator industry was begun in 1939 at the request and in cooperation with The Institute of Boiler and Radiator Manufacturers. The work has been carried on by the committee in cooperation with the Division of Simplified Practice of the National Bureau of Standards.

COMPENSATION LAWS

enacted at 1947 sessions of 5 state legislatures are analyzed by Industrial Hygiene Foundation.

The legal committee of Industrial Hygiene Foundation has issued an analysis of the five new state occupational disease compensation laws enacted at the 1947 sessions of the legislatures. The memorandum also summarizes the amendment to the New York occupational disease law and reports the appointment of legislative commissions to study proposed occupational disease legislation for Vermont and Montana.

• **STATES.**—The five states which have enacted new laws are: Iowa, Nevada, Texas, Tennessee, South Dakota.

The Nevada and South Dakota statutes and the New York amendment became effective July 1. The Tennessee law became effective March 12, the Iowa statute goes into force on October 1. The Texas act becomes effective 90 days after the adjournment of the Legislature.

• **INVESTIGATION.**—Theodore C. Waters, chairman of the foundation's legal committee, reported that the two legislative commissions have already started their work. The Vermont commission will investigate working conditions in industrial plants and will study the need for providing compensation. This Commission is scheduled to present its recommendations by December 15, while the report of the Montana Commission is to be presented to the 1949 session of the assembly.

• **PROVISIONS.**—The new laws give lengthy lists of compensable diseases, and make special provisions for compensation resulting from silicosis, with limitations on monetary liability and on the time for disablement or death.

Longest category on compensable diseases among the new laws is contained in the Texas legislation, which includes poisoning by beryllium, the etiology and pathology of which was discussed in a paper, by the late Dr. L. U. Gardner of the Saranac Laboratories, posthumously presented at the annual meeting of the Industrial Hygiene Foundation at Mellon Institute last fall.

• **COMMENT.**—"The enactment of this legislation," Mr. Waters commented, "shows the increasing interest being taken by state governments in the problem of industrial health.

"In practically every instance mentioned, provision is made for the appointment of a state medical board which will determine controversial medical questions.

"The commission created by House Bill No. 373 of the State of Montana is to be comprised of five members, made up of two members from industry, two from organized labor, and a duly licensed physician and surgeon resident in Montana. They will make a detailed study of occupational disease, and suggest measures whereby undesirable existing conditions may be remedied."

HIGH SPEED COMPUTERS

using electronic digital principle may revolutionize data compilation and classification.

The National Bureau of Standards has been commissioned by the Bureau of Census and the Office of Naval Research to construct two high speed electronic digital computing machines which may well revolutionize the methods of classification and compilation of data and of numerical computation.

• **ELECTRONIC SPEED.**—The computers are to be of the automatically sequenced digital type. Automatic sequencing reduces the intervention of a human operator to a minimum while electronic rather than electromechanical or relay type components assures speeds measured in millionths of a second for the arithmetic operations of addition, subtraction, multiplication, and division.

The machines will be capable of handling huge compilation problems and of solving the most complicated differential equations in engineering and physics. They will perform, upon instruction, predetermined sequences of calculations running into the hundreds of operations without the intervention of human operators. The result will be the solution of problems in days that would take years if attempted by present standard machines.

In the opinion of outstanding authorities in the field of applied mathematics, wind tunnel and model ship basin testing will be aided by machine computation. At the present time it is only theoretically possible to predict all of the changes involved when an aircraft is in flight, for example. Practically, mathematical solutions to these problems are impossible because it would take years to solve the equations involved by present methods. Answers are now found by laborious tests in wind tunnels and ship basins, observing the action of one part of a craft when certain forces are applied at another part. With the new high speed electronic machines much of this informa-

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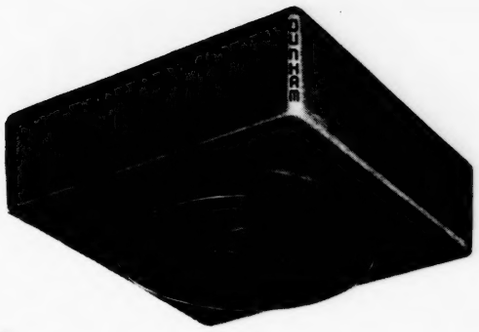

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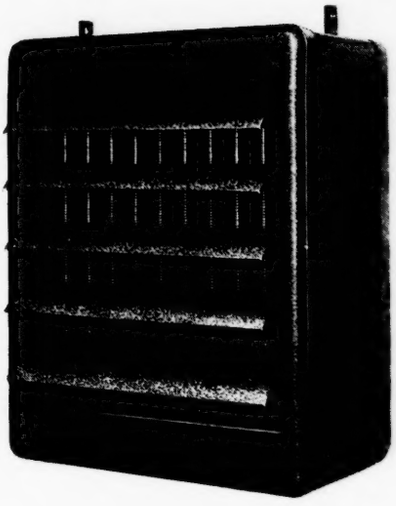

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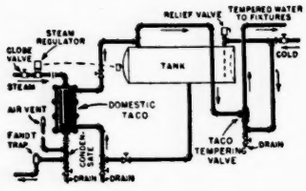

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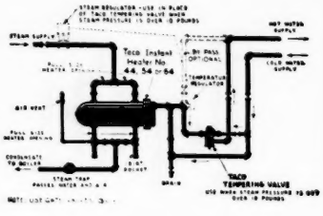
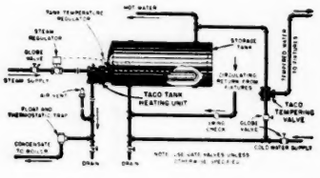


Taco Tank Units
72 sizes

Tank Heating Units
All 72 sizes can be used with high pressure steam



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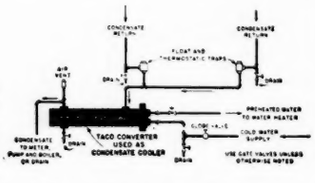
Can be used as water heaters, condensate coolers, water preheaters and heat exchangers to convert steam to hot water radiation.



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tion will be available, in a matter of minutes from the computer, in printed form if desired. The complex computations involved are no longer beyond the reach of the applied mathematician.

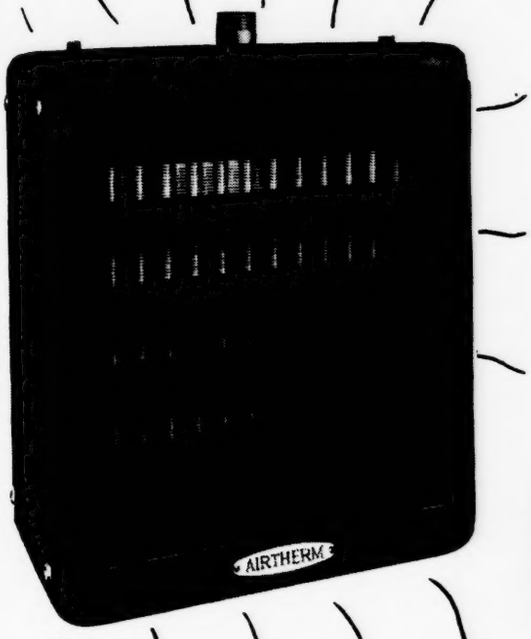
• **ELECTRIC BRAIN.**—The machines under construction are to have built-in "intelligence" capable of distinguishing between orders and data presented in coded form. Design specifications call for internal memories in which 5,000 or more 10 or 12 digit numbers and orders combined can be stored. The machines will be able to transfer numbers and orders between their internal organs and memories within a few millionths of a second. Numbers and orders will be taken automatically from a continuous storage medium in the form of a film or tape, and the machines will know when to depend on their internal memories and when to obtain information from this external tape. At predetermined steps in computation, the computers will be able to choose and execute alternative orders upon the basis of the result of the preceding steps. They will know when computations have been completed to a pre-assigned accuracy and will either print the results at that time or store them on an external tape for printing later.

Federal activity in the computing field stemmed principally from the efforts of the War and Navy Departments to acquire high speed machinery constructed specifically for critical wartime computation needs. There were three significant developments in this period: (1) an electromechanical computing device (the IBM Sequence Controlled Calculator) of the Harvard Computation Laboratory, (2) relay type computing machines of the Bell Telephone Laboratory, and (3) an electronic computing machine (ENIAC) of the Moore School of Engineering of the University of Pennsylvania, designed and built under the direction of Dr. J. W. Mauchly and J. P. Eckhart.

• **CURRENT PROGRAM.**—A significant result of the intensive development and use of the high speed computing machines during the war is that designers have been provided with operating data which would have taken years to accumulate under normal conditions. Experience now indicates rather clearly both the merits and the deficiencies of existing machines. The mathematical phases of the program of the National Bureau of Standards are under the direction of Dr. J. H. Curtiss, assistant to the director and in charge of the Bureau's mathematical and statistical work, while the electronic phases are conducted by the electronics section of the Ordnance Development Division under the direction of Harry Diamond, chief of the division.

The program involving the Census and Navy machines includes contractual relations with industry. For example, the Raytheon Corporation and the Electronic Control Company have active roles, both organizations having experts in this field. Associated with the Raytheon Corporation is Dr. George R. Stibitz, chief designer of the Bell Telephone large-scale relay computing machines. The Electronic Control Company has been established by Dr. J. W. Mauchly and J. P. Eckhart to design and construct such machines. The Navy machine will be available to the armed services

SAVE FUEL



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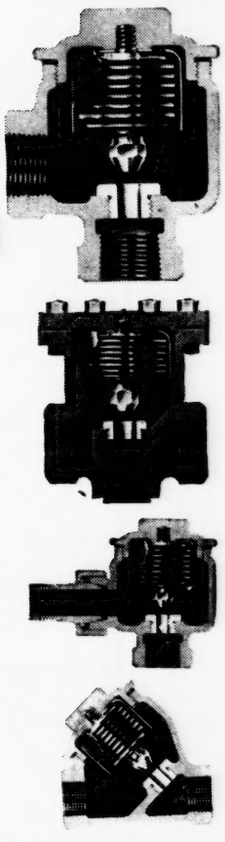

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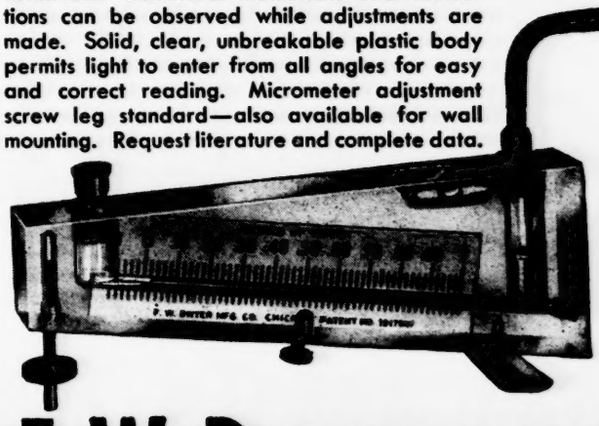

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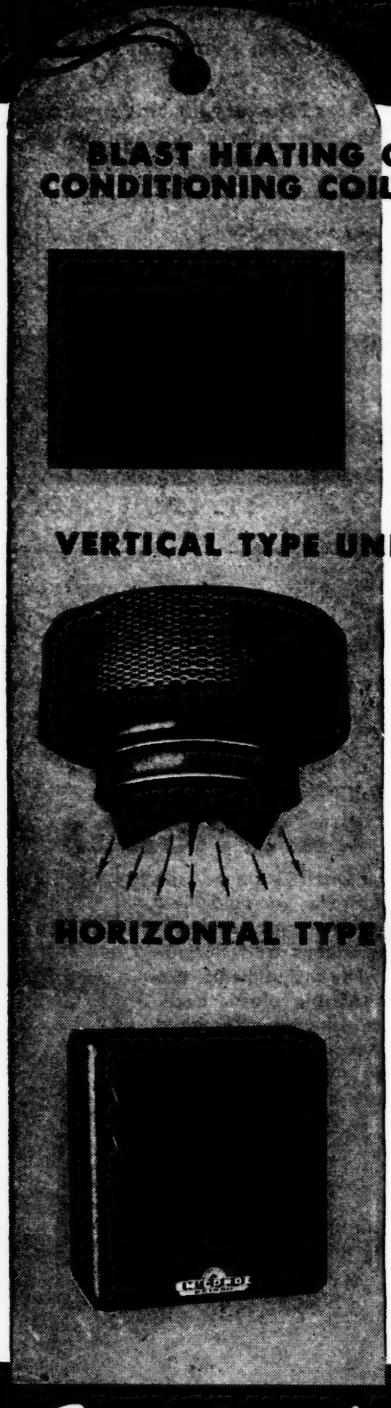

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and to other government agencies as well as private industry.

• **COMPUTING LAB.**—According to present plans the Navy machine will be located in a large general-purpose computing laboratory, which will also be equipped with standard business-type computing machinery and will be operated by the National Bureau of Standards. This laboratory will be staffed with personnel trained in the methods of numerical analysis. It will contain an analytical section which will conduct basic research in applied mathematics and will assist in formulating problems mathematically and preparing them for numerical solution.

HEATING COURSE

sponsored by I-B-R and University of Illinois will be 3-day course on steam and hot water heating.

A three day short course on the problems of steam and hot water heating will be sponsored by The Institute of Boiler and Radiator Manufacturers and the University of Illinois, September 9, 10, 11, at the Navy Pier branch of the University of Illinois, in Chicago.

The program will be conducted on the shop plan and will include lectures, discussions, and actual design problems to acquaint the student with the problems of steam and hot water installation.

• **TOPICS.**—Such topics as heat loss through building construction, resistance to flow in pipes and fittings, factors affecting comfort, the selection and placement of radiators and convectors, heating domestic hot water, and the selection of pumps and controls will be taken up during the course.

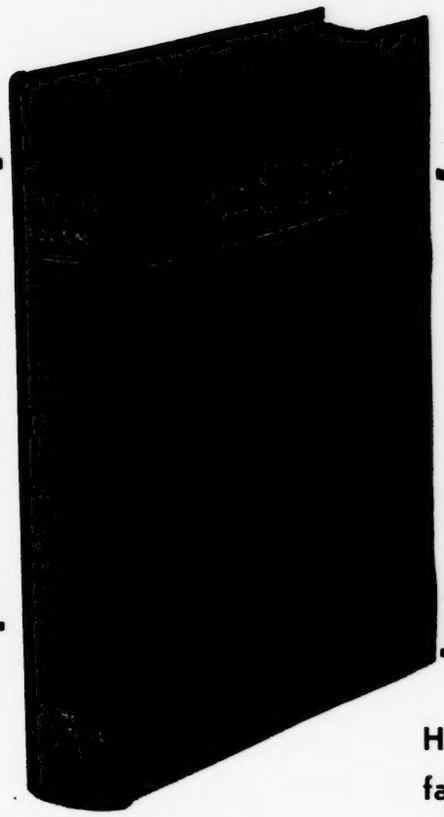
Much of the subject matter presented will be drawn from results obtained from research tests conducted in the I-B-R Research Home on the University of Illinois campus in Urbana, Illinois.

A $15.00 tuition fee will be charged by the University to include the cost of textbooks and classroom supplies. Individual living expenses will be paid by the student. Certificates will be presented to the students certifying satisfactory completion of the course. The certificates will bear the seals of both the University of Illinois and the I-B-R.

Because the number of students admitted to the course will be limited, advance reservations should be made. Requests for registration should be addressed to Mr. H. C. Rountree, Assistant Director, Division University Extension, Room 118A, Illini Hall, University of Illinois, Champaign, Illinois. Reservations will be made in the order in which they are received.

BRIEF

• A successful run-in test of the first centrifugal compressor ever to use *propane in a refrigeration cycle* was completed last month by Carrier Corp. Propane is an inexpensive by-product of petroleum refining.



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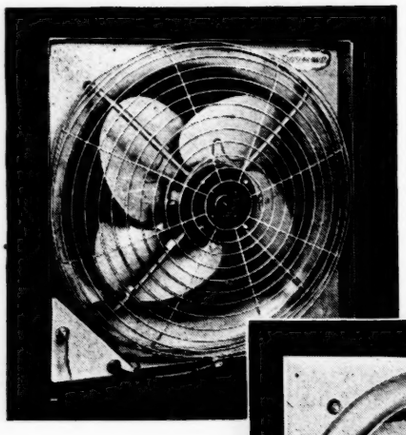

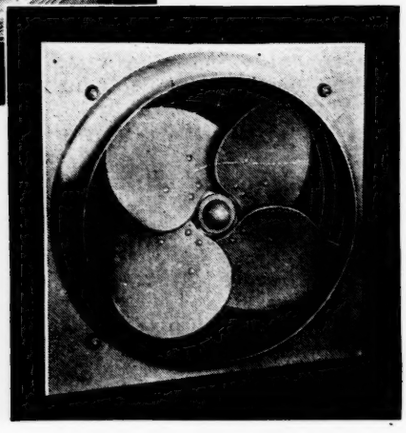

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Finned Coils

Kennard engineered finned coils for heating and cooling applications are the subject of a 34-page, 3-color catalog and engineering manual, No. 47A, which covers direct expansion coils, water coils, steam coils, and steam distributing tube coils. Rating and selection tables are included, and supplementary engineering data cover final temperature and condensate ratings for steam and booster coils, air friction charts, temperature rise constants, valve and piping notes, a mean temperature difference chart, etc. A two-page psychrometric chart is attached to the back cover.—*Kennard Corporation, 1819 South Hanley Road, St. Louis 17, Mo.* **332**

Boiler Sound Film

A motion picture showing fabrication, assembly, and function of modern marine boilers has been produced to acquaint engineers and students with construction and operation of such boilers. The 16mm sound film, "Steam Power for American Sea Power," has a running time of 30 minutes.—*Marine Department, The Babcock & Wilcox Co., 85 Liberty St., New York 6, N. Y.* **333**

Alloy Pipe Fittings

Nibcoloy stainless steel and nickel alloy fittings are described in Catalog No. 901. Three methods illustrating the ease of joining the fittings to produce smooth inner walls which permit an undisturbed flow of liquid are shown. Accurate labeling of fittings permits the precise matching of physical and metallurgical properties of tubes and fittings in a new installation and at any time in the future. Roughing-in dimensions and prices for the complete series of Inconel, Monel, Nickel and Stainless Steel 304, 347 and 316 fittings from ¼ in. O. D. to 4 in. O. D. are listed.—*Northern Indiana Brass Co., Elkhart, Ind.*..... **334**

Stainless Steel Fittings

Bulletin 47-1, two colors, eight pages, describes Midwest stainless steel welding fittings including elbows, returns, tees, caps, reducers, etc., with sizing and selection data. Directions for welding Austenitic stainless steels are included.—*Midwest Piping & Supply Company, Inc., 1450 South Second Street, St. Louis 4, Mo.* **335**

Steam Generator

Bulletin No. 1215 tells of an automatic steam generating unit which is said to produce steam in as little as 18 minutes. Known as the "Powermaster Steam Generator", the complete unit consists of the boiler, oil-burner, condensate return system, and automatic control panel. Installation requires only the necessary electric, oil, and water connections and flicking the starting switch.—*Orr & Sembower, Inc., Morgantown Road, Reading, Pa.* **336**

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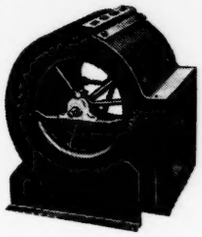

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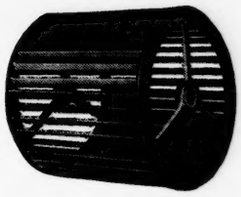

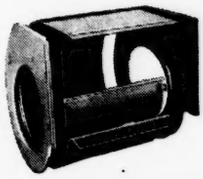

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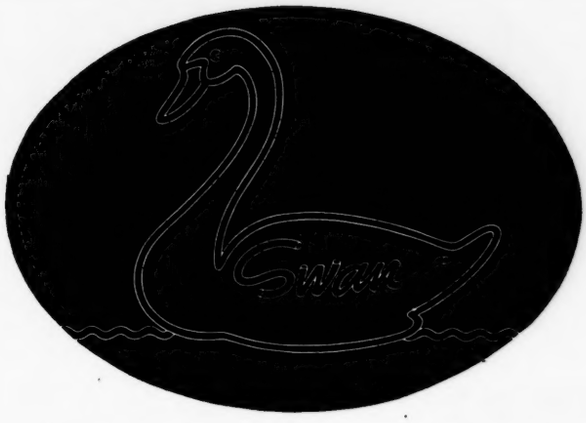

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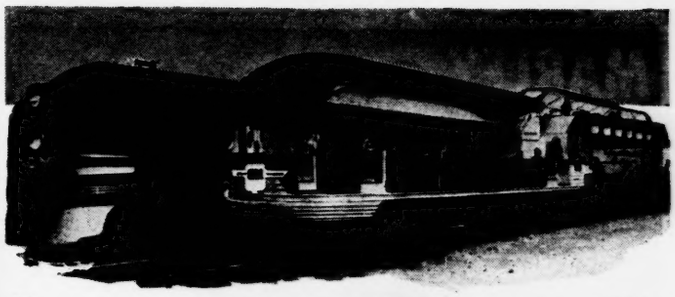

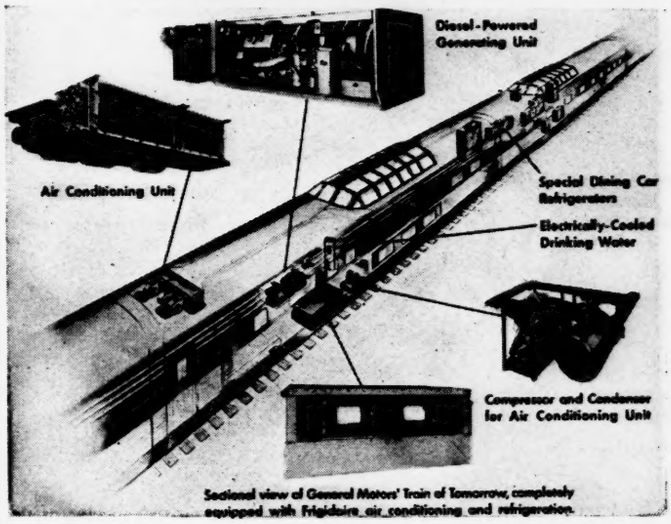
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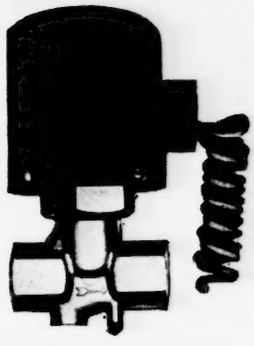

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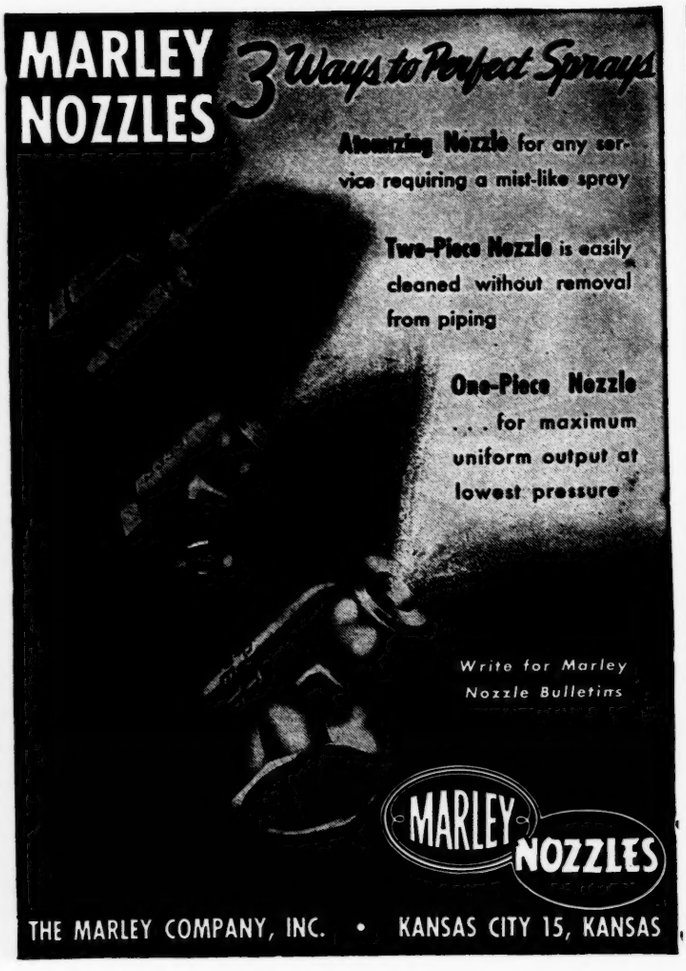
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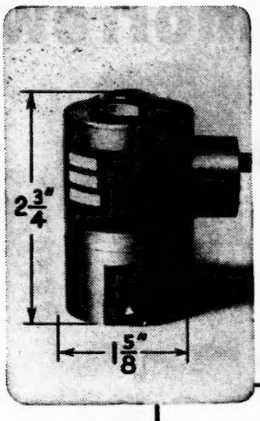

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A 10-page data folder gives dimensions, weights, and part numbers of seamless welding tees, elbows, flanges, and other fittings.—*Ladish Company, Cudahy, Wis.* 337

Surface Pyrometer

Catalog No. 160 illustrates and describes a new Pyro surface pyrometer. This is an all purpose instrument with interchangeable extension arms and thermocouples and is said to be suitable for reading both metallic and non-metallic surface temperatures. — *The Pyrometer Instrument Co., 103 Lafayette St., New York 13, N. Y.* 338

Flexible Hose

Flexaust, a spiral-wire-reinforced flexible hose, is the subject of Bulletin No. 26, 4 pages, 2 colors.—*American Ventilating Hose Co., 15 Park Row, New York 7, N. Y.* 339

Radiant Heating

A 12-page consumer's guide to radiant heating explains the principles and advantages of residential radiant heating.—*The H. B. Smith Co., Inc., Westfield, Mass.*....340

Transformers and Voltage Regulators

An illustrated 12-page bulletin, No. 547, on voltage control features the latest developments in Powerstat variable transformers and Stabiline automatic voltage regulators. Bulletin shows ratings, detail drawings, photographs, and performance and engineering data. —*The Superior Electric Co., 259 Church St., Bristol, Conn.*....341

Centrifugal Pumps

A new bulletin, No. 52B6691, 4 pages, 2 colors, tells of the operating advantages and construction features of "Pedrifugal" pedestal type centrifugal pumps. Nine features are shown in diagram, and selection tables aid in sizing pump, motors, and drive for desired capacity. — *Allis-Chalmers Manufacturing Company, Milwaukee 1, Wis.* 342

Water Gauges

Water level gauges for boilers in stationery, locomotive, marine, and refinery service are described and illustrated in an eight-page booklet with sizing and other data.—*Ernst Water Column & Gage Co., Livingston, N. J.* 343

Electronic Instruments

Bulletin 231, 12 pages, two colors, describes Bailey electronic instruments, for temperature, pressure, flow and other practice. Instruments include recording and dial reading controls, and electric circuits are diagrammed.—*Bailey Meter Company, 1050 Ivanhoe Rd., Cleveland 10, Ohio.* 344

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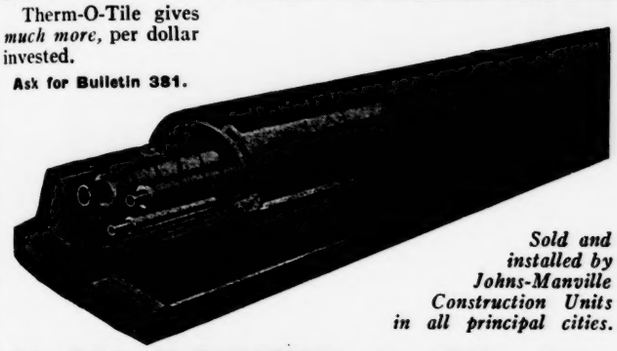

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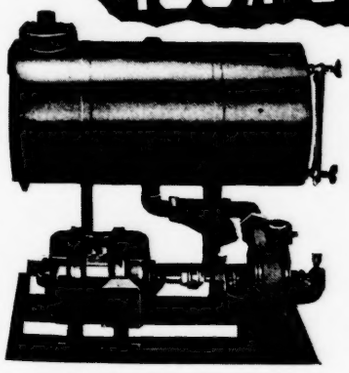

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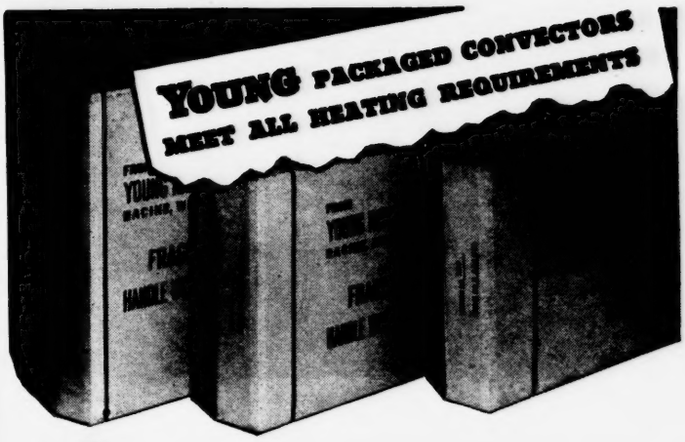

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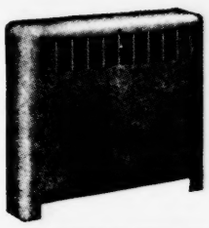

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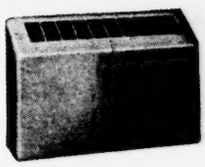

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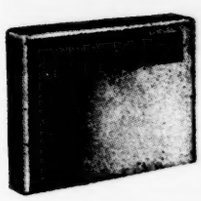

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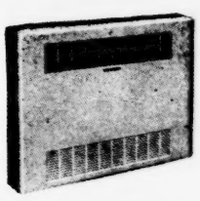

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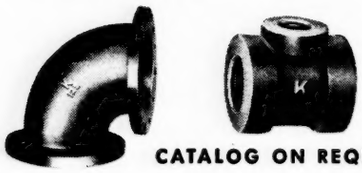

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Stainless Steel Valves

Catalog No. 47, 56 pages, spiral bound, describes Aloyco corrosion-resisting alloys of stainless steel and illustrates a line of valves, gage glass fittings, and piping accessories made of these alloys. Sizing charts and engineering application data are included.—*Alloy Steel Products Co., Inc., Linden, N. J.* 346

High Side Floats

A new bulletin describes Armstrong inverted bucket high side floats for discharging liquid refrigerant to low side of refrigerating systems. These floats are applicable to systems where all of the liquid refrigerant can be carried on the low side. The bulletin includes diagrams of the operating principle and installation practice, prices, capacities, etc.—*Armstrong Machine Works, Three Rivers, Mich.* 347

Welding Accessories

A new bulletin describes a complete line of welding accessories that will be carried in stock at district offices. These accessories, along with a line of electrodes for arc and gas welding, permit customers to get everything in the welding line, except the welding machine, from one source.—*Metal & Thermit Corp., 120 Broadway, New York 5, N. Y.* 348

Steel Boiler

The Kewanee type C steel boiler is the subject of an 8-page, 4-color catalog showing firebox details, SBI ratings, and application characteristics. — *Kewanee Boiler Corp., Kewanee, Ill.* 349

AUGUST, 1947

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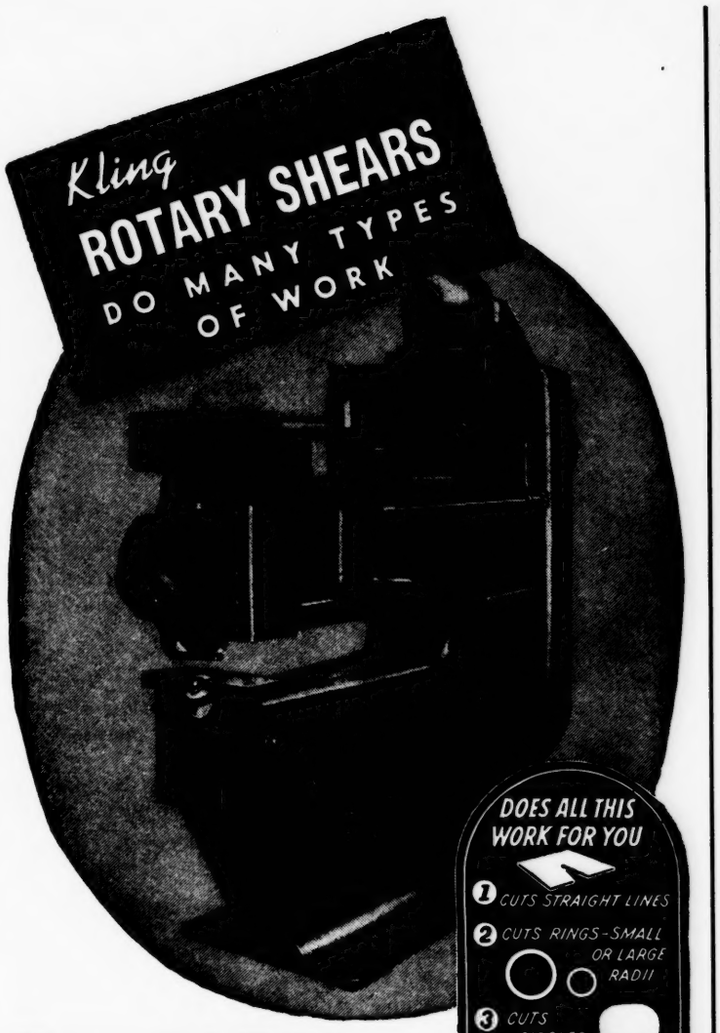

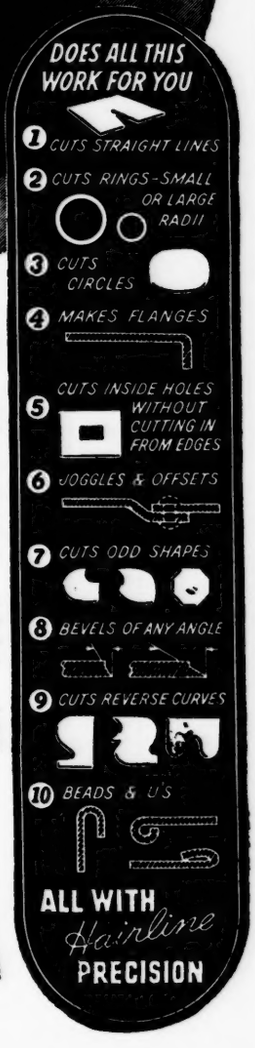
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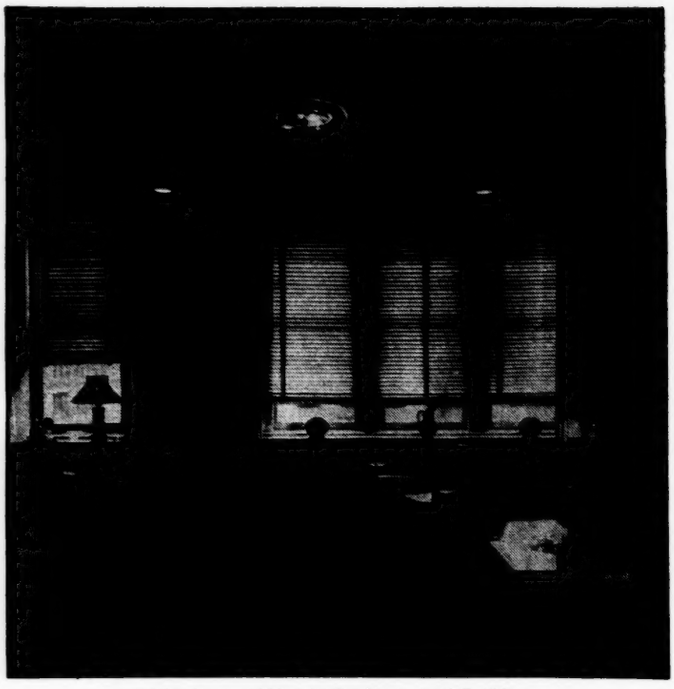

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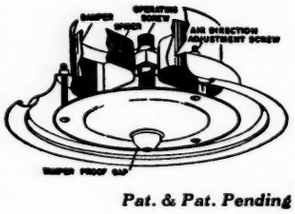

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Getting Personal

T. N. Adlam

T. Napier Adlam *(Snow Melting by Embedded Pipe*, page 61), is a graduate of Swindon Engineering College, England. He worked with A. H. Barker when the latter brought out his first patents for radiant heating and did much pioneer work with warm air methods of floor heating.

Mr. Adlam, who at present is Vice-President and General Manager of Sarco Manufacturing Corp., has patented numerous inventions relating to pumps, heating controls and other devices some of which are used in connection with radiant heating. He has had over thirty years experience with radiant heating. During recent years he has done a great deal of pioneer work in connection with radiant cooling and snow melting by means of embedded pipes.

He is a member of the Institution of Heating and Ventilating Engineers, England; American Society of Heating and Ventilating Engineers; the British Institution of Patentees; Fellow of the Royal Society of Arts; member of the exclusive Whitworth Society of Scholars.

Mr. Adlam is the author of Radiant Heating, (published by The Industrial Press) now in its second printing.

L. Bert Nye, Jr.

L. Bert Nye, Jr. *(Design of Year-Around Air Conditioning Systems for Residences*, page 83), was born in Washington, D. C. and attended Johns Hopkins University on a scholarship awarded by the Washington Gas Light Co. He graduated in 1934 with the degree of B.E. in gas engineering and then took a year of post-graduate work at George Washington University. He has been employed in the utilization department of the Washington Gas Light Co. since 1934. His work has consisted of laboratory and field testing of heating, air conditioning and other types of gas-operated equipment, and he has done general application work involving the selection of gas equipment, design of systems, and development of standards for the grading, selection, and installation of gas air conditioning. He has also taught air conditioning at the Abbott Vocational School and George Washington University. He is a member of ASHVE and president of the Washington Chapter.

Robert M. Towne (co-author, *Air Entrainment by Forced Hot Water Flow in Pipes*, page 93) was born in Seattle, Washington, and attended the University of Washington as a science major from 1937 to 1941. He was a shipfitter instructor in 1941 and 1942 at Seattle-Tacoma Shipbuilding Co. From 1942 to 1944 he was a lieutenant in the Coast Artillery. After a medical discharge from the Army, he re-entered the University of Washington and completed his B.S. in mechanical Engineering in 1946. He is at present employed as assistant mechanical engineer, Victor N. Jones and Associates.

Richard N. Stern (co-author, *Air Entrainment by Forced Hot Water Flow in Pipes*, page 93) was born in Valley City, North Dakota, and graduated in Civil Engineering from the University of North Dakota in 1925. After graduation he

worked for International Filter Company, Joseph T. Ryerson & Son, Carrier Corporation, and with air conditioning and refrigeration contractors in Minneapolis and Spokane. During the war, he was employed as a mechanical engineer for The Austin Company on Naval shore facilities and war material plants in Washington and Oregon. Since 1945 he has been employed as a mechanical engineer for Victor N. Jones & Associates, of Seattle.

F. L. Johnston

F. L. Johnston *(Lubricants for Refrigeration Compressors,* page 74) was born near Silver Creek, Miss. He attended Mississippi College where he received his Bachelor of Science degree in 1934. In February, 1937 he obtained his Masters degree at the University of Illinois. During the school year 1933-4 he was student instructor at Mississippi College and he held a similar position from 1935-6 at the University of Mississippi. Since his employment with the Shell Oil Co. in March, 1937, he has worked as a research chemist and products application engineer.

. . Since the Last Issue

Minneapolis-Honeywell Regulator Co. has formed a subsidiary company in Mexico. Marking the sixth foreign subsidiary organized by Honeywell, the new firm has been named Honeywell-Brown, S.A. All legal formalities have been completed and personnel engaged. Headquarters of the new company have been established in Mexico City. **Virgil H. Hiermeier** has been named manager of the Mexican company.

Owens-Corning Fiberglas Corp. announces the following personnel changes in the Toledo general offices: **P. J. Fluge** has been appointed manager of the yarns division. Prior to his new assignment, Mr. Fluge served as administrative assistant to the vice president in charge of sales. **M. G. Jensen** has been named manager of the storage battery sales section of the equipment and appliance division. **F. L. Meyers** has been appointed manager of the corrosion products sales section of the industrial division. Since the fall of 1946, Mr. Myers has been manager of the farm markets section of the building materials division. **R. E. Brown** has been appointed manager of the home insulation sales section of the building materials division. He joined the Fiberglas Corporation in 1945.

The **Automatic Devices Co.**, maker of the "Weather Man", outdoor type building temperature control has enlarged its distributing organization by the addition of three new representatives. **Thos. F. Burke,** of Thos. F. Burke Co., 218 Shoreham Bldg., 15th & H St., N.W., Washington 2, D. C., will cover the State of Maryland, Northern Virginia and the District of Columbia. **W. A. Hammond,** of W. A. Hammond, Inc., 261 Hyland Ave., Buffalo 13, N. Y., is taking over Northern and Western New York and Susquehanna, Bradford, Tioga & Potter Counties in Pennsylvania. **Edward E. Weingand,** 610 Hannah Avenue, Forest Park, Ill., will represent the company in the states of Wisconsin, Minnesota, Eastern half of North Dakota and Eastern half of South Dakota.

As advertised in TIME and NEWSWEEK

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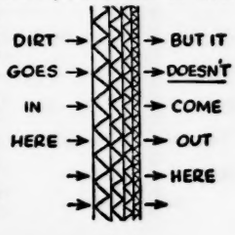

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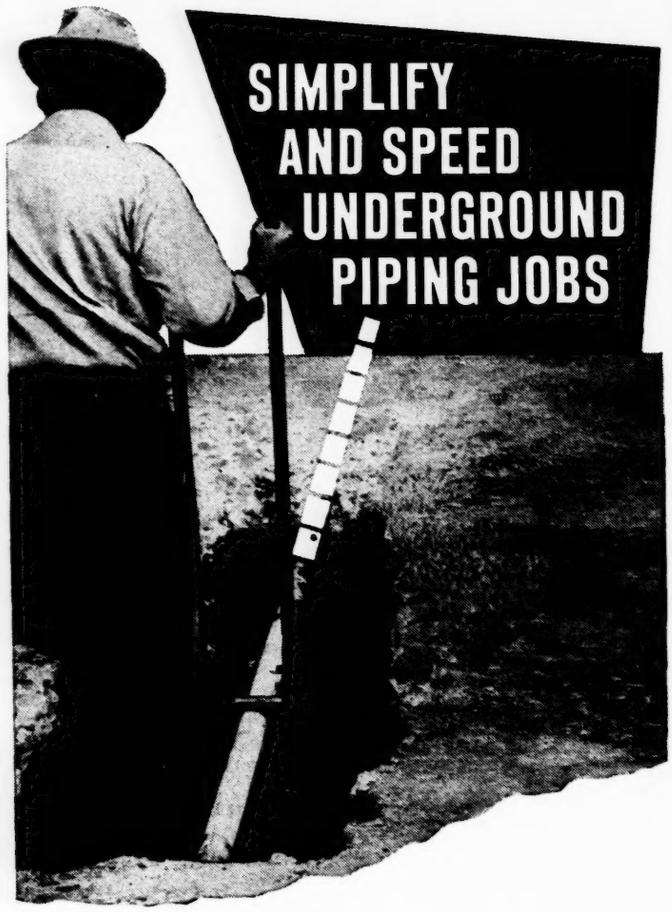

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Frank W. Hutchinson, who has been professor of mechanical engineering at Purdue University, has accepted an appointment as professor of mechanical engineering at the University of California (Berkeley) and has moved to that location. Professor Hutchinson, who is the author of a number of books and papers on radiant heating, heat transfer, solar heating, refrigeration, and other subjects, will remain on the Purdue staff as consulting professor of mechanical engineering and will commute between Berkeley, Calif., and Lafayette, Ind. He will continue as consultant for Revere Copper & Brass, Inc., The Trane Company, and Libbey-Owens-Ford Glass Co.

F. W. Hutchinson

Paul Mackall, vice-president, has announced the following changes in sales personnel of **Bethlehem Steel Co. J. M. Ellis,** general manager of sales, appointed assistant to vice-president. **K. L. Griffith,** assistant general manager of sales, appointed general manager of sales. **D. C. Roscoe,** manager of sales, sheets and strip, appointed assistant general manager of sales. **A. T. Hunt,** manager of sales, galvanized sheets and formed products, appointed manager of sales, sheets and strip. **M. C. Schrader,** assistant to the general manager, appointed assistant to the vice-president.

Bruce P. Hyde, Glen Ridge, New Jersey, has been appointed manager of the New York branch office of the **Herman Nelson Corp.,** manufacturers of heating and ventilating products. For the past year Mr. Hyde has been associated with Paul D. Harrigan and Frederick M. Hill, consulting engineers, New Haven, Connecticut. Associated with Mr. Hyde in the New York branch office will be **Charles E. Wandas** who has served as a product application engineer with the Herman Nelson Corporation for a number of years. **Richard M. Burbank** recently joined the staff of the Boston branch office as product application engineer, under W. N. Murray, manager. The Washington, D. C. branch office, where J. M. Osborne is manager, also has been enlarged by the addition recently of **F. M. Hewitt** as product application engineer.

The R. B. Rogers Companies, Inc., is moving from its New York plant to a larger, modern factory at Sanford, North Carolina. The move is already in progress and production is scheduled to start immediately on completion of the transfer. The Sanford factory is that of the Edwards Company, a division of the Rogers Companies. It has been equipped for the manufacture of the Rogers line of air conditioning products. The sales department and engineering and research laboratory will remain in New York. There will be no changes in management or personnel.

Oliver J. Prentice, director of public relations of the **C. A. Dunham Co.,** was the guest of officials of the company recently at a dinner at the Chicago Bar Association in honor of his 80th birthday and 27th year with the company. Mr. Prentice, a past chairman of the Illinois Committee of the Chicago Association of Commerce and Industry, was born in England and came to the United States when he was 20. He came to Dunham, large manufacturer of domestic, commercial and industrial heating systems and products, following an advertising career with the Chicago office of N. W. Ayer & Son. He is also president of the Illinois chapter of ASHVE.

O. J. Prentice

Representatives from the entire refrigeration compressor industry met for the first time in the industry's history on June 30 and July 1, at Hershey, Pa., for the purpose of setting up a voluntary code of refrigeration industry standards covering condensing units up to and including 5 hp. The men who met at Hershey were members of the newly named Industry Joint Engineering Committee. Frank K. Smith, Sales Manager, Tecumseh Products Company, Tecumseh, Mich., is committee chairman. The committee was created on the basis of separate favorable votes by the **Refrigeration Equipment Manufacturers Association** and the **Air Conditioning and Refrigeration Machinery Association.**

Kennard Corp., manufacturer of finned coils and blower units, has announced several changes in its executive group. Sam N. Kennard, III, president, said these changes are in preparation for the expansion of its line. **A. G. Loeffel** has joined the Kennard staff as vice-president in charge of sales and development. Mr. Loeffel entered the refrigeration field in 1916 with the York Corp., remaining with them for thirteen years. He later served on the staffs of the Detroit City Service Co. of Detroit, the Meyer-Blanke Co. of St. Louis, and for the past nine years was affiliated with Marlo Coil Co., St. Louis, Mo. **F. E. Ince** first joined the Kennard staff in 1940, previous to which he had spent some time in the industry as a private consultant and with the Alco Valve Co. of St. Louis. He was elected to the board of directors of the company in January of 1947, and at present is vice-president in charge of application and research. **L. C. McGowen** entered the refrigeration industry in 1933 as assistant branch manager for the General Refrigeration

A. G. Loeffel

F. E. Ince *L. C. McGowen* *F. G. Bietsch*

Corp., St. Louis. He joined the staff of the Alco Valve Co. in 1934, where he served in various administrative capacities for 10½ years. In June, 1944 he entered upon active duty in the United States Navy as a Reserve Officer. After being released to inactive duty by the Navy, he joined the Kennard staff in 1946 to serve as chief counsel and assistant to the president. He was elected to the board and also secretary of the company in January, 1947. **F. G. Bietsch** joined the Kennard staff in 1942, after having spent several years in the accounting field with various firms in St. Louis. He was elected to the board in January, 1947, and is currently vice-president in charge of accounting.

F. J. Bender of the **Sinclair Refining Co.** has been promoted to assistant to the president, Sinclair Petroleum Co., Addis Ababa, Ethiopia.

Modine Manufacturing Co., Racine, Wis. announces the appointment of **Thomas F. Burke Co.** as their representatives in the Washington, D. C. territory, with offices at 218 Shoreham Bldg., 15th and H Streets, Washington, 5, D. C.

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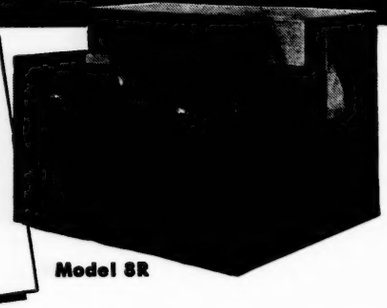

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George J. Stanley, director, vice-president and general sales manager for **Aluminum Company of America,** retired as vice-president and general sales manager on July 1. He will continue as a director of the company. Mr. Stanley has served the company for more than 42 years in both sales and engineering capacities. **Ralph V. Davies, Robert B. McKee,** and **Donovan Wilmot,** assistant general sales managers for Alcoa, have been promoted to vice-presidents of the company. Mr. Davies will also become general sales manager, succeeding Mr. Stanley. All three of Alcoa's new vice-presidents are members of the company's "25-Year Club," with over a quarter-century of service apiece.

Air-Maze Corp., announces the appointment of **Frank P. Purvis** and **Gordon S. Williams** as factory representatives to handle its line of air and oil filters and oil separators. Mr. Purvis is in charge of the Chicago office and covers the territory of Indiana, Illinois and Wisconsin. He was formerly with the Cooper-Bessemer Corp. in Mt. Vernon. Mr. Williams has charge of New England territory and his headquarters are in Milford, Connecticut. He was formerly engaged in consulting engineering work.

E. T. Tal, the originator of the Tal portable pipe bender, and president of **Tal Prestal Bender, Inc.,** Milwaukee, Wis., was presented with the Silver Medal of Merit of the Netherlands at a formal ceremony held at the Drake Hotel in Chicago on June 26. The award was given Mr. Tal in recognition of services rendered to Holland during and after the war. A native Dutchman, Mr. Tal headed "American Relief for Holland" in Wisconsin during the war, an organization which collected tons of food and clothing for the needy of that country. Mr. Tal not only successfully directed these service drives, but contributed substantially as an individual.

E. T. Tal

John True and **Burton B. Stuart** have been appointed New England district sales managers for **Raytheon Mfg. Co.'s** electronic air-cleaning precipitators; Mr. True taking charge of the home unit and room unit precipitators and Mr. Stuart handling the industrial precipitators. Both Mr. Stuart and Mr. True will serve as liaison between New England dealers and company applications engineers and will continue establishment of precipitator distributors in the territory.

Blake D. Hull, chief engineer, Southwestern Bell Telephone Co., St. Louis, Mo., was elected president of the **American Institute of Electrical Engineers** for the year beginning August 1, 1947, as announced at the annual meeting of the Institute held in Montreal, June 11. The other officers elected were: vice-presidents **G. W. Bower,** Haddonfield, N. J., **J. H. Berry,** Norfolk, Va., **I. M. Ellestad,** Omaha, Nebr., **D. I. Cone,** San Francisco, Calif., **D. G. Geiger,** Toronto, Ontario; directors **W. L. Everitt,** Urbana, Ill., **A. C. Monteith,** East Pittsburgh, Pa., **Elgin B. Robertson,** Dallas, Tex.; treasurer **W. I. Slichter,** New York, N. Y. The annual report showed a total membership on April 30, 1947, of 26,478.

The Coleman Co., Inc., manufacturer of gasoline pressure appliances and home heating equipment, has purchased the Wichita factory of the Culver Aircraft Company. The new plant adds nearly three acres of floor space to the manufacturing facilities of the Coleman company.

E. M. Platts

At **Joy Manufacturing Co.**, Pittsburgh, Pa., the post of vice-president in charge of sales has been filled by **E. M. Platts** of that company. This appointment marks the latest upward step in Mr. Platts' thirty-year career in the mining industry. Among other past activities, he was one of the principal incorporators of the La-Del Conveyor and Manufacturing Co. He headed up the sales force of that company since its inception, and when La-Del became a division of Joy Manufacturing Co., Mr. Platts moved over to Joy as vice-president in charge of coal mining sales. In his new position, sales of all Joy Manufacturing Company products will come directly under Mr. Platts' supervision.

Alan J. Bronold has been appointed general agency and contractor manager of the **Sturtevant Division of Westinghouse Electric Corp.**, Hyde Park, Mass. A veteran of 20 years as a sales and marketing specialist with Westinghouse, Mr. Bronold for the past four years was assistant to the vice-president in charge of sales at company headquarters in Pittsburgh. In his new position, Mr. Bronold will coordinate the headquarters activities of the heating, ventilating, air conditioning and Precipitron departments and the application of Sturtevant products for heating, piping and air conditioning contractors and for industrial process air conditioning systems.

Stratton & Terstegge Co., announces the change in name of the heating equipment manufacturing division from Anchor Stove & Range Division, to Anchor Division, Stratton & Terstegge Co. Anchor has been manufacturing stoves, ranges and heating equipment since 1865 and became a division of the parent company, Stratton & Terstegge in 1940. Also announced was the change of the Anchor Division sales offices from Louisville, Kentucky to the factory in New Albany, Indiana, P. O. Box 311.

Chase Brass & Copper Co. announced recently three major personnel changes affecting their extensive warehouse system. **Leland S. Hanson**, who has been manager of the Chase New York City branch since 1938, has been promoted to sales manager, Eastern Division, and will eventually make his headquarters at the company's main offices in Waterbury, Conn. **Herbert H. Bartlett**, manager of the Chicago branch since 1934, succeeds Mr. Hanson as manager of the New York branch. **G. Townsend Underhill**, who has been sales manager of the New York branch for the past several years, has been promoted to manager of the Chicago branch. All promotions are to be effective immediately.

Appointment of **R. D. Duthie**, of Chicago, Ill., as assistant to the vice-president has been announced by **Westinghouse Electric Corporation.** Mr. Duthie will head the Company's chain store activities and will be located in Pittsburgh. He succeeds A. J. Bronold who has been transferred to the Company's B. F. Sturtevant Division in Boston, Mass., as general agency and contractor manager.

Ransome Machinery Co., a subsidiary of **Worthington Pump and Machinery Corp.**, has recently appointed **Allan B. Kime** as eastern regional manager in charge of the sale of Ransome positioning and turning roll equipment. Mr. Kime's headquarters will be located at the Ransome plant Dunellen, New Jersey.

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